$800 INTEL RIG REVAMPED!

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WE'VE GONE AND BUILT A BETTER VERSION OF OUR BUDGET WONDER — AND YOU CAN TOO!

a+pc

YOUR EXPERT GUIDE TO TODAY'S TECH

July 2018
Issue 456

THE COMPLETE MANUAL

DIY TECH SUPPORT

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- → D-LINK COVR: MESH NETWORKING FOR LESS
- → OCULUS GO: STANDALONE VR ON THE CHEAP

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REVIEWED PAGE 18

4G LTE

Vigor2862L Series

Mobile Internet Solution for Small-to-Medium Businesses

DrayTek Aust & NZ
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Multi-WAN router with 4G LTE SIM card slot (150/50Mbps), VDSL2/ADSL2+, Gigabit Ethernet WAN, IEEE 802.11ac (AC2000), SPI Firewall, and 32 x VPN tunnels including 16 x SSL-VPN tunnels

Vigor2862Lac

Vigor2862L

Aust/NZ VDSL NBN Ready

Ethernet WAN NBN Ready

Ethernet WAN UFB Ready

SIM Card

32x VPN

LTE/4G Specification

LTE/4G category 4
150Mbps downstream and 50Mbps upstream
4G LTE FDD Band: 1, 3, 4, 5, 7, 8, 28
4G LTE TDD Band: 40
3G WCDMA Band: 1, 2, 5, 8

The LTE feature makes the Vigor2862L series router an ideal solution for applications such as:

- Provision of Internet access on public transport such as coaches, buses, trains, freighters, etc.
- Temporary installations such as disaster recovery and emergency situations, exhibitions, sporting events, etc., where Internet access is required for a short period.
- Quick setup for new branches waiting for xDSL/Ethernet WAN (e.g. NBN)
- Remote locations with no fixed line or NBN coverage.
- Load Balancing or Failover backup for an existing primary Internet connection which can be any of ADSL/VDSL/Cable/Ethernet broadband.

Key Features

- Card slot for FDD & TDD 4G LTE SIM card supports band B1/B2/B3/B4/B5/B7/B8/B28/B40
- VDSL2/ADSL2+, Gigabit Ethernet WAN port, 1 x USB port, and 1 x 4G LTE SIM card slot
- 1 x USB 2.0 port for 3G/4G LTE Modem, FTP server, network printer or temperature sensor
- Single WAN or Multi-WAN Load Balance and Failover
- 4 x Gigabit LAN ports with multiple subnets and 50,000 NAT sessions
- Integrated IEEE 802.11ac (AC2000) Wave 2 wireless Access Point; dual band; up to 1.7Gbps throughput for Vigor2862Lac
- Object-based SPI Firewall and CSM (Content Security Management) for network security
- Supports QoS functions
- IPv6 & IPv4
- Increased IP addresses (1022) and IP subnets (8)
- 16 x VLANs for secure and efficient workgroup management
- 32 x VPN tunnels (including 16 x SSL VPN tunnels) with comprehensive secure protocols
- Fast VPN throughput, VPN load-balancing and backup for site-to-site applications
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- Central AP Management for deployment of multiple wireless VigorAPs
- Central VPN Management for 8 remote Vigor routers
- Free Smart Monitor Network Traffic Analyzer (30-nodes)
- Supports VigorACS 2 (Central Management System) for multi-site deployment
- 2 years back to base warranty

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Should big tech companies be broken up?

APC editor Dan Gardiner *wonders if we've reached the point where some tech companies are too big for their — and our — own good.*

A new proposal from a group of US Democratic senators, going under the title 'Freedom from Facebook', is seeking to make Facebook break off certain sub-brands into separate entities, and introduce features that will force the social giant to play nicer with competitors. This isn't just a toothless political stunt either — the move is backed by a US$300M advertising campaign that will seek to build popular support for the idea, and the group has taken out full-page adverts in several major US newspapers.

The campaign's homepage at **freedomfromfb.com** makes a pretty reasonable opening pitch: "Facebook has too much power over our lives and democracy. It's time for us to take that power back." To remedy this, it proposes, "The FTC should spin off Instagram, WhatsApp, and Messenger into competing networks, require interoperability, so we have the freedom to communicate across social networks, and impose strong privacy rules that empower and protect us."

In the wake of Cambridge Analytica and Russia's meddling in both Brexit and the 2016 US elections, and ongoing public uncertainty about how much digital privacy we should expect, it's certainly a timely question — and one that a lot of people will be on the fence about, myself included.

What's primarily at stake is the broadly accepted notion that Silicon Valley giants can acquire successful (and potentially threatening) tech upstarts and then either suppress their ideas and technologies or integrate them into their own products. I'd hazard that this trend is something that's happened in business for as long as it's been around, so the question is "When does that become dangerous?"

There are no easy answers in this debate. Calling for Facebook to allow more interoperability certainly sounds good on paper, but that would almost certainly open up access to our private data to even more bad actors...

Breaking up monopolies seems dubious. Perhaps the way forward is a global charter of digital rights — something along the lines of Europe's GDPR, but enforced and accepted by all the countries in the G20, might let us enjoy the benefits of big tech while also limiting the potential damage such size can do. Might that be enough? ■

DAN GARDINER
EDITOR-IN-CHIEF
dan.gardiner@futurenet.com

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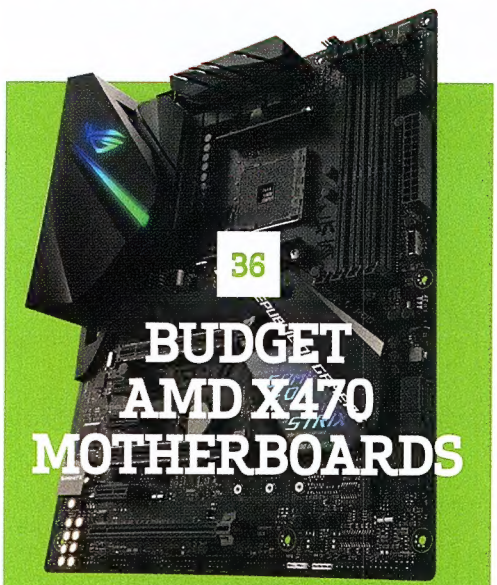

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ISSUE 456, JULY 2018

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Many people no longer want, understandably, any of their information to be transmitted to third parties. The answer is Abelssoft's GClean. It targets and governs this flow of information that otherwise accumulates in massive data centres cataloguing millions of users. GClean searches the user's entire computer for existing Google software, then allows the cessation of all personal data transmission with a single mouse click.

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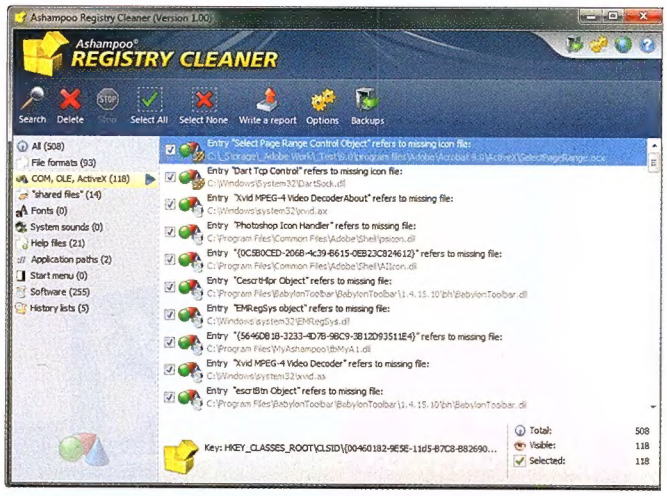

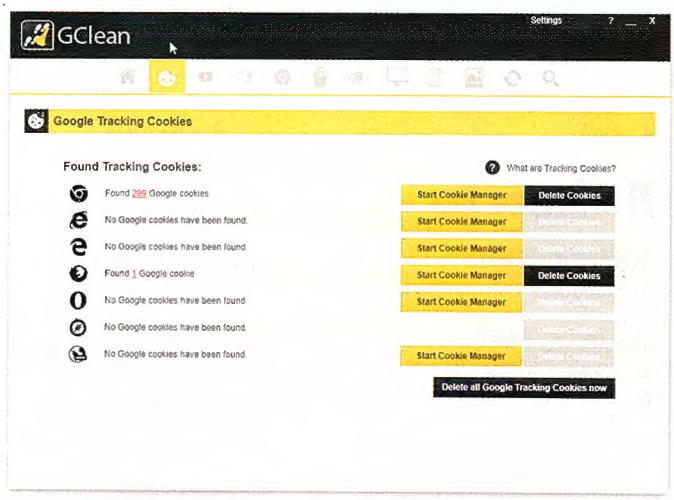

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Digital driver's licences are finally coming to NSW

YET ANOTHER REASON TO NOT CARRY A WALLET.

The NSW Government has announced that it will allow the state's drivers to display their licences using a smartphone app. Digital driver's licences will be offered through the Service NSW app starting in 2019, but a specific launch date has yet to be confirmed. NSW residents who use a physical photo ID instead of a driver's licence as proof of identity will also be able to opt for a digital version on the NSW Services app when the rollout happens next year. SS

Researchers push hidden messages to smart speakers

'DO YOU SPEAK-A MY LANGUAGE?'

While smart speakers still struggle to understand your grandma when she says: "Ohkei Googoo", researchers in China and the US have discovered that they are already adept at deciphering covert instructions that are inaudible to humans. The University of California, Berkeley, was able to dial phone numbers and go to websites using hidden audio-based commands and have said that, in the wrong hands, the hidden smart speaker language could be used to unlock security doors or even make purchases without users being aware. JB

Victoria overhauls its traffic camera system

IN RESPONSE TO WANNACRY ATTACK.

Amongst the hundreds of thousands of victims of last year's WannaCry cyber attack was Victoria's traffic cameras and, a year on, the state's government has announced an overhaul to the system. At the time of the attack, the 'integrity' of the system was reportedly unaffected, but the network's governance and security protocols will now be changed according to recommendations from the Road Safety Camera Commissioner, John Voyage, to protect from future cyber attacks. SS

Cambridge Analytica files for bankruptcy

Company responsible for 'making America great again' shuts down in wake of scandal.

After wafting an orange-haired clown into America's highchair and successfully convincing swathes of Brits that it was a 'fit' idea to Brexit the EU, the social media consultancy firm Cambridge Analytica is shutting up shop. Knowing intimately how much fake news propagates the pages of Facebook, the company took to its website and Twitter to post the official announcement that it would be filing for bankruptcy following the widespread exposure of its pivotal role in the Facebook data abuse scandal – and, well, that blatant video footage capturing the company's commercialisation of political blackmail.

Like all good racketeering business ventures, the company then attempted to rebrand as Emerdata Limited, an entirely *different* business that dealt with "data processing, hosting and related activities", shared the same business address and featured an identical set of management staff as the cast from Cambridge Analytica. This delicate deception was, however, detected and the crafty new business was subsequently also shuttered. **Joel Burgess**

Google and Microsoft find new strain of Spectre and Meltdown

PATCHES COULD AGAIN DEGRADE PC PERFORMANCE.

Security researchers at Google and Microsoft have found a new variant of the Spectre security flaw that was first reported back in January this year. Called Speculative Store Bypass (or Variant 4), the new strain exploits similar vulnerabilities as the older Spectre and Meltdown bugs but, according to Intel, uses a different method to access information. The new variant can be exploited by running script files on programs like web browsers. If hackers manage to successfully exploit this vulnerability, they'll be able to get sensitive information off other parts of the program, like another tab in the case of browsers.

Intel, however, has classified the new bug as medium risk, claiming that most of the exploits it uses were fixed in the original wave of patches that were rolled out. As we saw with previous Spectre and Meltdown patches, these new processor firmware updates could potentially reduce system performance. Intel says the mitigations will "be set to off-by-default", meaning users who don't enable the new protections should not experience the negative impacts of the patch, but obviously won't be protected either, leaving the end user to decide between security and speed. **Sharmishta Sarkar**

Google under investigation in Australia for large scale Android data harvesting

The Oracle has spoken...

Google is under investigation in Australia after software company Oracle produced evidence that the internet giant has been collecting user data from millions of Android smartphones without consent. According to the report submitted to the Australian Competition and Consumer Commission (ACCC), Google's parent company, Alphabet, has been illegally receiving detailed information on search histories and user locations of Australian Android owners, amounting to about a gigabyte of data per device each month. It has been alleged that the data collection began as part of Google's Street View project, but is still ongoing, coming at the cost of the consumer.

Oracle's report claims that the transfer of information uses up part of a user's data quota each month, alleging that Aussies are unwittingly paying their telcos to have their details sent to Google. Australian telcos have asked Google for more information regarding the allegations. But in the meantime, with over 10 million Android users in Australia, it raises serious privacy concerns so soon after the Facebook-Cambridge Analytica scandal, and has brought the country's Privacy Commissioner into the investigation as well. **Sharmishta Sarkar**

New VPNFilter malware targets routers and NAS boxes worldwide

500,000 HOME AND SMALL-BUSINESS DEVICES ALREADY INFECTED.

A virulent new strain of malware has infected more than half a million consumer and small-business networking devices. Discovered by researchers at Cisco and dubbed 'VPNFilter', the infection targets numerous routers and network-attached storage (NAS) devices from major manufacturers like Netgear, QNAP, TP-Link and Cisco itself. The malware is able to spy on network traffic and potentially steal website usernames and passwords, and can also be used to 'brick' infected devices, rendering them inoperable.

Although the exact creator of the malware is as yet unknown, Cisco has stated that the "sophisticated modular malware system" appears to be the work of a state-sponsored or state-affiliated actor. The malware's creators appear to be focused on infecting devices located within Ukraine, although the virus has been discovered hiding on equipment in 54 countries. The malware is designed in such a way that it can have additional capabilities added after the initial infection and it could persist after a device had been rebooted — although the FBI has reportedly managed to seize a server being used by the botnet, which has subsequently disabled VPNFilter's ability to reactivate itself after a reboot. **Dan Gardiner**

Apple is removing apps that share location data with third parties from the App Store

POLICY VIOLATORS WON'T BE ADMITTED BACK.

Apple is cracking down on apps that share user location data with third parties without "explicit consent" by informing developers that such apps won't be sold on The App Store. Developers must now "remove any code, frameworks, or SDKs" that abet location sharing if they want their apps to be reconsidered for sale. Apple wants developers to not only make the permission more explicit, but also inform customers how and where that data will be used. **SS**

Cryptocurrency endorsed by McAfee not so secure after all

EXPOSES DATA OF 25,000 INVESTORS.

Cryptocurrency startup Bezop, which was endorsed by John McAfee on Twitter, has failed to protect a MongoDB database, resulting in the exposure of details on 25,000 investors. The data — including names, addresses, email addresses, encrypted passwords, wallet information, as well as copies of driver's licences and passports — was visible online to anyone with an internet connection and a knowledge of where to look. **SS**

Google's code of conduct no longer includes "don't be evil"

JUST... DO THE RIGHT THING.

The phrase "don't be evil" has been Google's unofficial motto since 2000, and although Alphabet changed the employee code of conduct to "do the right thing" in 2015, Google still held on to the old charter. That, however, changed recently, when the new code distributed to employees removed most reference to the phrase, with one exception. The last line still reads, "And remember... don't be evil, and if you see something that you think isn't right — speak up!" **SS**

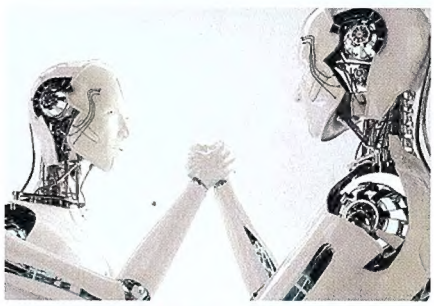
numbercrunch

CARMEL SEALEY LOOKS AT THE NUMBERS DRIVING THE BIG TECH NEWS

$100 million

HOW MUCH THE DEVELOPER OF FORTNITE HAS PROMISED TO INVEST IN PRIZE MONEY

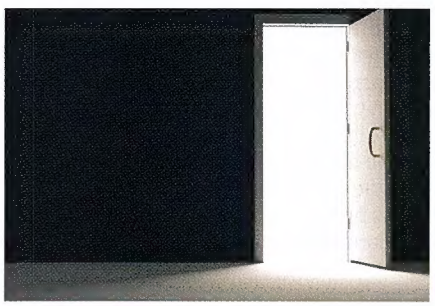
Fortnite is already such a big gaming phenomenon that publisher Epic Games has announced its intentions of injecting US$1m into the game's first year as a competitive esports title. The publisher has not yet explained exactly how this money will be distributed to winners, nor is it clear how successful in terms of profits the game has been so far across all available platforms — although analysts have suggested that microtransactions have raised more than US$50m on the iOS version of the game alone!



80%

PORTION OF THE VIDEOS THAT YOUTUBE TOOK DOWN IN 2017 THAT WERE INITIALLY FLAGGED BY AI

Of the 8.28 million videos that the Google-owned company took down during the fourth quarter of last year for content violations, around 80% had initially been flagged by AI rather than staff or users. The sheer number of videos uploaded each day to YouTube means that relying solely on humans to monitor content is impossible, so this announcement is a positive sign for the future of AI video flagging systems.



6.5x

FACTOR BY WHICH THE FBI INFLATED THE NUMBER OF CRIMINALS' PHONES IT CAN'T UNLOCK

US law enforcement has been attempting to force phone manufacturers to implement backdoors on their devices for years now, but towards the end of 2017, the FBI claimed that it had 7,800 devices that potentially held information that could help them solve cases. After *The Washington Post* debunked this figure, however, the FBI has since admitted that figure was a calculation error, and that the number is closer to 1,200. Derp.

8.4 million

NUMBER OF WEBSITES THAT FACEBOOK TRACKS YOU ACROSS

Think you're safe from the social media behemoth just because you have no account? Sadly, its reach goes far beyond its website and apps. Somewhere in the vicinity of 8–11 million other websites — each hosting a Facebook Like or Share button, or pixel (ad-optimising code) — are reporting back on your activities whether you want them to or not. Simply visiting one of these sites is enough for Facebook to gather data about you and build up a profile, including information such as location, time you visited the site and how long you spent there.

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NUMBER OF GOOGLE EMPLOYEES WHO QUIT OVER DEFENSE DRONE COLLABORATION

According to a report from Gizmodo, about a dozen Google employees have quit over the ongoing collaboration between the company and the US Department of Defense. Despite a petition signed by almost 4,000 Google staff declaring the company "should not be in the business of war", the company is reportedly going ahead with Project Maven. In another disturbing turn of events, Google's "don't be evil" motto has been moved from the preface of its corporate code of conduct and ostracised to the very last sentence. Encouraging. ■

techbrief

» CARMEL SEALEY WADES INTO A CURRENT NEWS TOPIC TO TAKE A CLOSER LOOK

Tech that can save your life

The inventions, gadgets and wearables that keep you from shuffling off this mortal coil before your time.

We as a species have a remarkable habit of getting ourselves into trouble, so it makes perfect sense that small chunk of our population (the smarter chunk, obviously) are working hard at the drawing board, trying to find ways of prolonging our lives in one way or another. Now, we're not talking about the basics here – things like air bags, smoke alarms, life jackets, pedestrian crossings and so on – we're talking about high-tech gadgets of the modern age! Like superheroes, many of these inventions had humble beginnings in the world of drones or fitness trackers, but were trained by a wise master (tweaked and redesigned by scientists and engineers) to become the big-biceped, cape-wearing life savers that we know today.

Westpac to the rescue with its lifesaver drone

Eyes in the skies.

The Westpac-sponsored Little Ripper Lifesaver fleet consists of "sophisticated single and multi rotor UAVs" (unmanned aerial vehicles, aka drones) that not only participate in search operations but also deploy "rescue devices" — namely ULBs (which stands for "you little beauty", seriously!) that drop life rafts — and keep in communication with those who require help. But they're not confined to the beach. These drones also have land and snow rescue divisions. And they're adorable!

The bicycle helmets that can detect a fall

Now capable of being shiny and connected!

Some helmets (such as the Livall, pictured) now come equipped with extra safety lights for the benefit of vehicles coming up behind, allow communication between helmets — to allow riders to talk to each other while on the go while keeping their eyes on the road — but, importantly, they can also send SOS signals through a companion app to a designated emergency contact if an accident has been detected. And some people argue that helmets don't keep you safe. Pff.

Vigo

The wearable that keeps you alert while driving.

One of the most dangerous things we humans do is drive, and it's even more dangerous once you put a sleepy human behind the wheel. The Vigo is a supposedly unobtrusive headset that monitors your eye and head motion to detect whether or not you're getting drowsy. If it thinks you are, it will stimulate you with light, sounds or vibrations, which should hopefully be enough of a reminder that you're putting your own and other lives at risk, and encourage you to stop, revive and survive.

Fitness trackers that monitor your vitals

More than counting your steps.

Many fitness trackers and smartwatches profess to monitor your heart rate, but some (such as the Apple Watch, some Fitbits and also the Withings Pulse Ox, pictured, now owned by Nokia) are so sophisticated that they can detect changes in a user's regular levels and alert them, potentially staving off a heart attack. They don't always get it quite right, however. Anecdotally, a friend of your humble writer received a warning alert from his Apple Watch in the moments leading up to him proposing to his now fiancé. Nyaw. ■

gadgets

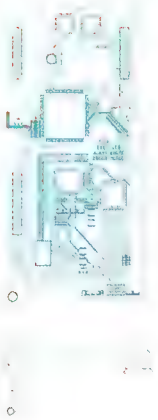
» GEAR WE WANT

NURAPHONE

Headphones that adapt to your ear's sound profile.

$499 | WWW.NURAPHONE.COM

In what has to be one of the weirdest headset designs we've seen, the nuraphones combine a classic over-ear headphone shape with alien probe-like in-ear buds that protrude from where you'd expect the regular drivers to be. This shape creates a uniquely isolated air pressure chamber that, it's claimed, effectively blocks out higher-frequency outside noise and gives the headphones the novel ability to draw on the audio-quality benefits of both over-ear and in-ear drivers. Oh, yeah, and it uses noises that are made by your inner ear to create a personalised audio profile that'll apparently help you get the best sound from any type of music. **JB**



HTC EXODUS

The phone for hardcore blockchain enthusiasts.

$TBC | WWW.HTC.COM/AU

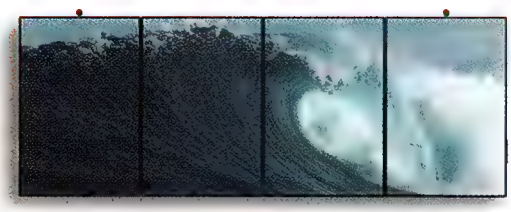
HTC is betting on crypto with this new smartphone, which was announced at the Consensus 2018 blockchain conference in May. While basically any smartphone has the ability to download a wallet app to store and exchange cryptocurrency, HTC's new device will come with its own onboard wallet that already has built in support for Bitcoin (including the Lightning Network) and Ethereum and hopes to "support the entire blockchain ecosystem" by launch. In addition to this, HTC is building a localised transfer network that uses the Exodus smartphones as nodes to transfer funds and minimise mining fees, in a way that's kinda like its own mini Lightning Network-like bolt-on. **JB**

MICROSOFT SURFACE HUB 2

Professional Hubba Hubba.

$TBC | WWW.MICROSOFT.COM

If you're into the business of business, Microsoft's update to its conferencing and display PC, the Surface Hub 2, will have you as excited as your first merger or that time you brought those costs down and revenues up. Supported by its very own wheelable A-frame stand, the new rotatable Hub 2 features an updated custom Windows interface and a dedicated webcam. The original Hub came in 55- or 84-inch sizes, while the Hub 2 will be available in a smaller 50.5-inch almost-bezelless form factor, with "greater than 4K" resolution. It's expected to launch some time in 2019 and although we don't know pricing, we're hoping the smaller unit will cost less than the first Hub's starting price of $13,499. **JB**



NATIVE UNION X LA BOITE PR/01

A multi-functional speaker.

£699 | NATIVEUNION.COM.AU

In tech, collabs have become the new Rose Gold. The latest comes courtesy of gadget accessory obsessives Native Union and French acoustics specialist La Boite, the results of which are wrapped up in the handsome PR/01, a compact home-dwelling speaker designed to provide you with advanced connectivity and ear-gasmic acoustics. The PR/01 isn't interested in being a flash in the pan – it's classically styled and wants to live in your home. The Bluetooth aptX-infused PR/01 is geared up to deliver powerful, high-fidelity sound, and charge Qi-enabled phones from a plate on top. A concealed drawer hides various audio inputs, one USB-C and two USB-B ports. Make room on your console table for the handsome PR/01, which promises rich sound and minimal faff.

LENOVO MIIX 630

2-in-1 to impress.

$TBC | LENOVO.COM.AU

Always-connected laptops get a new addition to the fold in the form of Lenovo's sprightly Miix 630, a 2-in-1 with integrated 4G LTE, for what Lenovo promises to be "true anytime, anywhere mobility". You want that. Especially if you regularly work in coffee shops, on the train or while waiting for your plane – with onboard 4G LTE, you won't have to rely on finding a Wi-Fi hotspot. Lenovo has also bundled in a detachable, full-sized, backlit keyboard and a digital pen so that you work and play better. Amping your productivity further, meanwhile, is a Snapdragon 835 Mobile PC Platform on Windows 10 S. The Miix 630 is also lightweight, quiet and flexible, so you can stuff it in your bag when you're done. Lenovo's looking to impress, and keep you ever-connected.

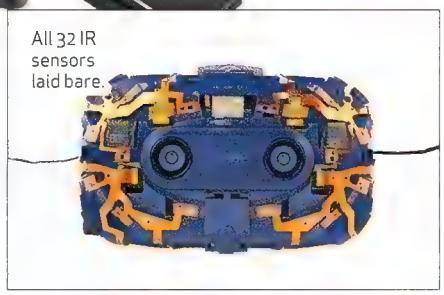
YUNEEC HD RACER

A budget drone for racing.

US$180 | YUNEEC.COM

There are big bucks in drone racing now, with prize purses totalling US$1 million in the biggest events. FPV drone racing isn't for everyone, though, as motion sickness often ensnares newbie pilots. So how can you give this exciting new sport a go without spending a truck-load of cash? Try the new Yuneec HD Racer, an affordable FPV racing drone built for beginners and experts, offering a range of flight modes to suit. It only has a six-minute battery life, but that's enough to blast around a course a few times. The drone can also shoot 1080p video at 60fps, with a low-latency FPV feed putting you in the heart of the action (watch a live feed from the built-in camera on your smartphone or via a compatible FPV headset). Yuneec's budget flyer is perfect for trying your hand at FPV drone racing without angering your bank manager. ■

howit'sdone



All 32 IR sensors laid bare.

The Vive Pro features dual 1440p screens developed by Samsung.

HTC Vive Pro

Is this VR headset virtually as easy to take apart as it is to use?

With the lightning pace of tech releases, it's hard to believe nearly two years have passed since the first Vive was released. Today, HTC brings you the first headset in what's bound to be VR's v2.0 and we're bringing you the pieces.

MAJOR TECH SPECS

- Two 1440p AMOLED displays for combined res of 2,880 x 1,600
- 90Hz refresh rate
- Dual front-facing cameras, dual mics and headphones
- Accelerometer, proximity, gyroscope and IPD sensors
- 360° headset tracking via up to four Lighthouse 2.0 base station IR emitters
- Wireless with the not-yet-released Vive Wireless Adapter

KEY FINDINGS

- We haven't even started disassembly, and already we're seeing some repair-friendly features. Spring contacts and standard Phillips screws connect the modular headphones to the headset, making for easy removal and replacement. HTC even tells you how to remove them. We peel off a couple foam pads and unsnap a plastic compartment cover to find the end of the Vive Pro's fancy custom cable. Although a completely wire-free experience is not yet available, HTC managed to fit all the power and data lines into a single cable that routes neatly up and over your left ear.
- Wading through the sea of divots in the front cover, we find a couple (or four) that hide Phillips screws. While we're not huge fans of hidden or tamper-evident screws, they're much better than glue or proprietary heads. After a bit of work with an opening pick, the outer shell splits down the middle and slides off. The Vive Pro's unsettling new gaze makes us feel bad about peeling its face off — sorry, Johnny Vive Five.
- Inside the covers, we spot familiar IR-friendly windows. All these purply dots are a bit like sunglasses for the IR sensors beneath — helping to filter out visible light, so the sensors can more easily spot the IR beams from the Lighthouse base stations. Much like on the original Vive, there's a spiderweb of photodiodes just under the sleek surface of the Pro — 32 in total. Unlike the Oculus Rift, this headset is looking for IR light — rather than emitting it.
- Where the original Vive kept nearly all its onboard silicon on a single board, the sequel uses two small ones. One services the displays, I/O, and one or two other things. While we are excited about the chips, we're a little bummed that the ports are still soldered to a board. Non-modular, high-stress components like ports can be a pricey repair. This board also hosts the linear potentiometer that formerly lived on its own FPC. That small slider tracks where you position the displays when making IPD adjustments.
- **Repairability Score:** 8 out of 10 (10 is easiest to repair). Disassembly with standard tools is straightforward, non-destructive, and free of booby-traps. Newly added earphones are completely modular, and come with instructions for fitting and removal. Standard Phillips and Torx screws secure most components. High-wear comfort pads are fastened with Velcro. Compatibility with existing base stations and controllers means you may already know how to repair the accessories. Adhesive is used sparingly, securing lenses, mic and sensor arrays. This is an unusually complex device and HTC does not provide a service manual, so use extra caution if attempting a repair. ■

$800 INTEL RIG REVAMPED!
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Issue 456
YOUR EXPERT GUIDE TO TODAY'S TECH
DIY TECH SUPPORT
EXPERT PICKS FOR ADDING MORE MEMORY, SUPERIOR STORAGE OR A POWERFUL NEW GPU TO YOUR PC
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→ CUSTOMISE MAC OS'S FINDER
NEW GADGETS & GEAR REVIEWED
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the lab
» LATEST REVIEWS
apc HOT PRODUCT
Oculus Go
Can finally take VR mainstream?
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It's a standalone device, meaning it has finally cut the cord from the PC which was needed to run its older and more powerful brother, the Oculus Rift. It's also, of course, done away with the smartphone. You won't be slotting anything into the Oculus Go except your face when you slip on the plush headset.
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This is virtual reality for the casual gamer, the relaxed consumer of media, the person without the time, money or interest in setting up a PC to power a higher-end headset. This is, essentially, VR for everyone.
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Once on, the Oculus Go feels incredible on the face. The plush inner lining is soft and pillowy, yet has an airiness to it as well. Oculus said it consulted with the garment industry in making the Go, and this is apparent in the headset's premium comfort feel.
As for wearing the device, it's important to point out that a fair amount of light seeps through the bridge of the nose. Some people are really bothered by light leakage in VR as it breaks the immersion, while others are able to ignore it after a while. For us, it was a case of 'a little of column A, a little of column B'.
The weight distribution is very much in the front, too. It rests right on your upper cheekbones, and once you've worn it for a while, an achiness starts to set in. We have yet to find a headset that has perfected weight distribution. Of the premium headsets on the market, the HTC Vive has done the best job, so far, in minimising it.
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With Touch, your hands are brought into VR, and the controllers track your hand and arm movements. With the Oculus Go controller, though, it's not much more than a point-and-click remote, though it can move around in the virtual space, and it does so quite faithfully.
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MSI X470 Gaming M7 AC

MSI GT75 Titan 8RG-096AU

Aorus X9 DT

Inside APC

Find out all about *APC*'s editorial policies, test practices, how to read the benchmark results and more.

APC is Australia's oldest consumer technology magazine – having been consistently in print for over 35 years, since our first issue way back in May 1980 – and we take that heritage and responsibility very seriously. While our focus is obviously on the personal computer – it's in our name, after all – the very definition of the PC has changed and shifted markedly since the early 1980s. As such, we touch on many other areas of tech too, from smartphones and apps to peripherals, accessories, online services and beyond. We have two main goals: to track down the best of modern tech and also to help our readers make the most of it.

We're also an open church in terms of platforms. We know most people aren't wed to a single brand's products and use a variety of devices. And like you, *APC*'s journalists want to know what's good in tech – no matter what platform it resides on.

INDEPENDENT REVIEWS

Championing technology doesn't mean we're unrelenting yes-men, however, and *APC* aims to be as objective as possible in all our coverage. That means identifying the best products from multiple perspectives – the best performance, best value and best features and, ideally, the products that offer the best mix of these three.

As a matter of policy, reviews published in *APC* are not shared with product-makers prior to print. We will contact vendors under certain conditions; for example, if we have a problem testing a product that seems to indicate it may be faulty, or to invite a vendor to clarify how a particular feature works. If an *APC* reviewer has any potential conflicts of interest involving a brand, the review will always be assigned to another writer.

LABS TESTING

Despite being a small magazine with limited resources, *APC* still still strives to conduct the most rigorous, objective scientific tests and benchmarks we can so as to make our reviews as unbiased as possible. We use a variety of tools and programs for this, including many freely available benchmark suites for assessing media encoding, general system performance, gaming and battery life.

In most cases, for the benchmark results published in *APC*, you can assume that higher is better. There are certain tests that deviate from this rule and where the opposite is true; in those cases, we've flagged the results with a note explaining as such.

We use both tables and graphs for displaying results; the latter are our preference due to their ease-of-readability, but tables are more compact, so we use these in cases where thoroughness is preferred.

epinions

"I hope you agree (and cover) the fact that just because these companies say they don't retain your data, or that they protect it, doesn't mean a person isn't at risk."

TRUST NO ONE

I'm happy to see *APC*'s tackling the online privacy issue. I hope you agree (and cover) the fact that just because these companies say they don't retain your data, or that they protect it, doesn't mean a person isn't at risk. I don't trust 'em.

For example, in many cases, when it comes to your data, a company's employees can get to it, government agencies can get to it, and (as history's repeatedly shown) hackers can often get to it, too. They lie, and have been caught lying many times over the past decade or so. Because of this, over the years, I've settled on three approaches to protect my privacy:

1. Encrypt all email to and from family.
2. Minimise what I actually enter into the internet.
3. Use privacy-focused services, when available (such as the search engine DuckDuckGo).

Greg Bell

GOOGLE KNOWS ME BETTER THAN I DO (OR SOON WILL)

The Google I/O conference showcased a lot of very interesting new tech on the not-so-distant horizon, but one thing made me feel very uneasy. Gmail's predictive text has gone absolutely mental. Just by typing a few words, Google will suggest what the rest of your sentence will be (a feature accessed by apparently hitting Tab). Their example was asking a friend to join them for tacos.

Strange how using a free service for 15 years turns into the company knowing exactly how you talk, isn't it? (The answer to that is no, by the way.)

Google knows us all probably better than we ourselves do, by monitoring our clicks, our likes, our keywords, our interactions... Why wouldn't they start to 'help' us write our own personal emails?

While this will obviously help some people – mostly those who probably don't like typing or have trouble doing so – it really does feel like the setup to an episode of *Black Mirror*... maybe one in which a global corporation follows you wherever you go and suggests that, perhaps you don't want to walk into that part of town because the restaurants you prefer going to are in the opposite direction, and everyone at first thinks that's great, but then it starts working against you through your eye implants, only showing you things it thinks you'd enjoy and hiding things out of your comfort zone and... Where was I?

Imagine how samey all emails will become if Google is writing them all for you. I imagine your sub-editor has had a ball with this one, putting the commas in the right place and removing any double spaces I may have missed [***Not too many, actually! — Sub-Ed***]. Will emails soon become personality-less? Will they all be perfectly scribed – perfect, by Google's standards anyway? Will there be no intended mis-spellings or wrong turns of phrases? Will it all become soulless?! Please, Google, let me keep my faulty English!

John Smith, in hiding from Google

MOORE'S LAW COMES TO A SHUDDERING HALT

I've bought a new computer every few years since the 1980s and had become accustomed to getting a machine that was faster, more capable, with more storage and at a lower price than the previous one, thanks, I'm told, largely to the magic of Moore's Law.

Moore, whoever he was, must have died: if I were to replace my five-and-a-half year-old Dell Inspiron 15R 5520 laptop now, I would just get rubbish for the same money. The processor would be slower, it would still have Windows 10, the hard drive would be no bigger or even smaller if I went for a solid state one, and it would probably have fewer USB 3 ports and not even a DVD burner.

I'll be hanging on to the old Dell until it dies, or until a new Moore comes along who can get PC development moving in the right direction again.

Dennis Tonevi ■

APCMAG@FUTURENET.COM

Come on, have your say!

We want to hear what you think. Add to these discussions or email your views (in fewer than 250 words) to **apcmag@futurenet.com**. All correspondence becomes the property of *APC* and is subject to editing. Letters must include full name, street address, suburb, state and phone number to be considered for print publication. Address and phone details will not be published.

On today's internet, safeguarding your digital privacy likely means abstaining

For lack of meaningful rules, consumers ought to protect themselves from data behemoths, Shaun Prescott writes.

When Facebook became embroiled in the Cambridge Analytica scandal earlier this year, many were dismayed to find that their personal data was being used (indirectly or otherwise) as a tool in political manipulation. Major political campaigns, particularly in the United States but also in Australia, have long used metrics and data in order to both spread their messages and target the right people. And yet, the scale of Facebook and the ostensible use case of the site (read: to connect with friends) seemed completely at odds with the way it was being used by both data agencies and political parties.

But what can we do, other than to publicly scold Facebook, usually *on* Facebook? According to two Mozilla executives we spoke to, the only way to act against social and data behemoths like Facebook is to abstain from using them. In order to demonstrate the futility of real consumer awareness, the company (which created and owns Firefox) presented an art exhibition which aimed to depict how tangled and complex consumer agency is when it comes to how their data is used. In one performance which ran during the exhibition, a man read the entirety of Amazon's Kindle terms and conditions – and it took him 8 hours.

"Technology companies haven't been doing what's in the best interest of people," Mozilla CMO Jascha Kaykas-Wolff said. "There's an expectation that [users are] this strange hybrid of a robot and a lawyer. What technology companies do as businesses has so many different applications, the only way that an individual can understand that is to have legal expertise and robotic stamina to be able to read through it. With thousands of words on hundreds of pages to hit the terms of a service agreement, it's a kind of farcical consent."

The company claims that up to 25% of consumers practised discretion when deciding which online services to use, whether that be reading the terms and conditions or, in the case of Facebook, shutting their accounts entirely in the wake of the Cambridge Analytica scandal. And while this is positive, a Mozilla spokesperson rightly points out that tech companies ought to take the initiative to be more transparent with how our data is used. That means, perhaps not hiding the details in 100,000 words of text.

It's an important point to make, but let's use the climate change analogy. Individuals, whether in their tens of thousands or even millions, won't change emissions by using fancier, more 'green' light bulbs, and nor will massive emissions offenders, such as oil and gas companies, deliberately and meaningfully cut into their profits in order to save the world. Change must come from an administration level, and it must be unwavering and strong (and perhaps even more unlikely: without interests in the field). Whether that will actually happen, given the wealth and influence of some of Silicon Valley's most powerful companies, is another question. For now, the only way to escape the grasp of behemoths like Facebook is to not use them. ■

END USER

Share your stories!

If you have an interesting story about technology users, their experiences and the issues that affect us all (whether funny or serious), email us at **apcmag@futurenet.com**. All correspondence becomes the property of *APC* and is subject to editing. Letters must include writer's full name, street address, suburb, state and phone number to be considered for print publication. Address and phone details will not be published.

VR HEADSET

$299 (32GB); $369 (64GB) | WWW.OCULUS.COM/GO

Oculus Go

Is this the standalone headset that can finally take VR mainstream?

Oculus Go is, in many ways, the dawn of a new era in virtual reality (VR). It's a standalone device, meaning it has finally cut the cord from the PC, which was needed to run its older and more powerful brother, the Oculus Rift. It's also, of course, done away with the smartphone. You won't be slotting anything into the Oculus Go except your face when you slip on the plush headset.

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This is virtual reality for the casual gamer, the relaxed consumer of media, the person without the time, money or interest in setting up a PC to power a higher-end headset. This is, essentially, VR for everyone.

DESIGN

As soon as you take the Oculus Go out of the box, you feel like you're holding a device that costs $300. Its design is sleek and has some nice subtle touches; the front panel is a slightly different shade of grey in certain lights, for example. The straps are soft and adjustable, but while the headset feels secure on your head, we could feel it sliding up at times.

Once on, the Oculus Go feels incredible on the face. The plush inner lining is soft and pillowy, yet has an airiness to it as well. Oculus said it consulted with the garment industry in making the Go, and this is apparent in the headset's premium comfort feel.

As for wearing the device, it's important to point out that a fair amount of light seeps through the bridge of the nose. Some people are really bothered by light leakage in VR as it breaks the immersion, while others are able to ignore it after a while. For us, it was a case of 'a little of column A, a little of column B'.

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PERFORMANCE

Despite its relatively low price tag, the Oculus Go gives even the premium competition a run for its money. While it may lack the dev studio clout of Sony's headset, we were

"The sense of spatial audio is excellent, and hanging out with a friend from the other side of the world to watch a movie is an impressive, *Ready Player One*-like experience."

shocked to find that it offered a comparable experience to the PlayStation VR headset when the Go was pushed to its limits. As a standalone unit, it wipes the floor with the likes of Google Cardboard and even its own cousin (and also Oculus-developed) Samsung Gear VR, while also pushing what we should now come to expect for our money from the more expensive headsets.

Before talking up the surprisingly impressive performance aspects of the Oculus Go, however, it may be worth pointing out its most considerable limitation. The Go makes use of an 'Orientation Only' movement system – in other words, while you can turn your head and view a 360° world, and have your controller tracked within it, you can't move through the virtual space.

It's equally worth noting, though, that the Go is designed to be an entry point for the VR-curious and so, if they've never used a VR headset before, may not even realise the extra-dimensional element that is missing.

Once you're in a game or VR experience, however, it's hard to fault the Oculus Go. Tracking is accurate and comfortable, with little jerkiness that could otherwise increase the chances of feeling nausea.

The 5.5-inch, 538ppi panel (with a resolution of 2,560 x 1,440) is impressive, too, sharp enough to almost eliminate the 'screen-door' effect earlier headsets suffered from. Oculus told us it used a fast-switch LCD display with the Go to have better pixel fill, meaning the pixels are simply larger and thus reduce the screen-door effect as well. The goggles in front of the screen appear improved over those of the Oculus Rift, as well, which suffered from more pronounced glare than is present when using the Go.

It was a little bit fiddly to install, but the included glasses spacer was a welcome accessory, giving this glasses-wearing review team a little more room to accommodate our specs for comfortable viewing.

Battery life is a bit of a double-edged sword for the Oculus Go. You'll get around 2 hours of gaming from a 3-ish hour charge, or about 2.5 hours of video. However, you're unlikely to want to spend that much time in a single undisturbed stretch inside a VR headset's confines anyway, so it's hard to complain too much. Still, it'll be a push to get through an entire movie in one go, which is unfortunate.

We also noticed a rare problem (which we failed to replicate after further testing) where the Oculus Go appeared to drop frames when approaching a depleted battery.

It's worthy of the benefit of the doubt, but paired with the way some apps upon booting would very briefly flash the display white before settling, it suggests there's still room for a little optimisation here.

GAMES AND APPS

Games and experiences on the Oculus Go are a varied bunch – there are over 1,000 apps, movies, games and short-form VR experiences at launch, being a mixture of brand-new titles and remixed Rift and Gear VR content.

Oculus has a relatively open submission system for apps, making the quality of each experience vastly different – but there's already a lot of great stuff to play with, and we'd rather have the option of dipping our toes into less-polished titles than not at all.

But perhaps the best example of Oculus' ambition with the Go is the new Oculus Rooms app. This is a customisable social space in which you can hang out with pals floating around, playing chess, sharing photos and watching films.

The sense of spatial audio is excellent, and hanging out with a friend from the other side of the world to watch a movie is an impressive, *Ready Player One*-like experience.

It's worth noting that Oculus Rift games can't port over to Oculus Go, but as a sort-of consolation prize, Oculus Go does support cross-platform play between itself and the Oculus Rift and Gear VR.

PERFECT FOR VR ON THE CHEAP

All in, though, it's hard to argue with the performance of the Oculus Go. For a self-contained headset, not reliant on an external power source or processing unit like a phone, it delivers a fantastically diverse and approachable VR experience.

It's no Vive Pro, but Oculus Go is the sort of device that would have seemed unfathomable just a few short years ago.

■ Michelle Fitzsimmons & Gerald Lynch

Verdict

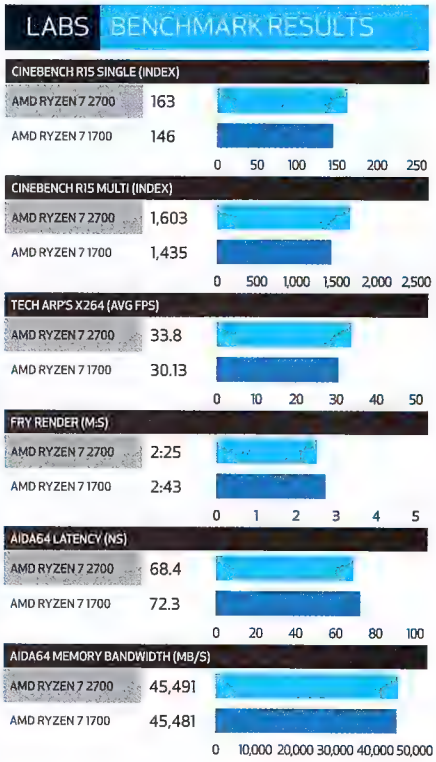
Features	★★★★
Performance	★★★★½
Value	★★★★½

While not perfect, the Go offers a comfortable fit, solid build, excellent visuals and the promise of content.

★★★★½

AMD PROCESSOR

$425 | WWW.AMD.COM


LABS BENCHMARK RESULTS
CINEBENCH R15 SINGLE (INDEX)
AMD RYZEN 7 2700 163
AMD RYZEN 7 1700 146
0 50 100 150 200 250
CINEBENCH R15 MULTI (INDEX)
AMD RYZEN 7 2700 1,603
AMD RYZEN 7 1700 1,435
0 500 1,000 1,500 2,000 2,500
TECH ARP'S X264 (AVG FPS)
AMD RYZEN 7 2700 33.8
AMD RYZEN 7 1700 30.13
0 10 20 30 40 50
FRY RENDER (M:S)
AMD RYZEN 7 2700 2:25
AMD RYZEN 7 1700 2:43
0 1 2 3 4 5
AIDA64 LATENCY (NS)
AMD RYZEN 7 2700 68.4
AMD RYZEN 7 1700 72.3
0 20 40 60 80 100
AIDA64 MEMORY BANDWIDTH (MB/S)
AMD RYZEN 7 2700 45,491
AMD RYZEN 7 1700 45,481
0 10,000 20,000 30,000 40,000 50,000

AMD Ryzen 7 2700

The tinkerer's choice.

AMD's greatest achievement with its first-gen Ryzen processors came from one tiny little CPU: the 1700. At first glance, amidst all the hype surrounding the 1800X and the hex-cored 5 series that followed soon after, we'd dismissed the lower-powered 1700 as nothing more than a lineup-filler designed for those on a budget, or power users looking for particularly good energy savings.

The reality was different. In our tests, our sample shattered our expectations, at least when overclocked, and easily kept up with – and in some cases surpassed – the 1800X. All it took was a little elbow grease, some additional voltage and a bump up in the multiplier. 4.0GHz was a cakewalk. In short, it was enough to convince this overclocking-obsessed reviewer to invest in one, and although we were fooled once by the inauspicious nature of AMD's sleeper agent, we sure as hell weren't going to be fooled again.

At its heart, the 2700 is quite a curious part. Much like the rest of this second generation of Ryzen, there's no architectural change, no new socket, no grand shift in manufacturing process or increased TDP – nothing. All performance gains are leveraged through intelligently designed smaller transistors, and a rethinking how Ryzen deals with memory latency. Because of that, AMD reckons you'll net a 10–15% performance increase across the board with this new generation compared to the previous. That's a bold claim, for sure.

As far as performance is concerned, the 2700 does exactly what you'd expect across our computational benchmarks in contrast with the last generation – managing an increase of around 12% across all four of our tests. In fact, it looks a lot more like a Ryzen 7 1800X than anything else right now. In Cinebench R15, it scored 163 points in single core versus the 1800X's 161, and 1,603 in multi versus the 1,640 of the 1800X.

So you get eight cores at 3.5GHz (or 4.1GHz for a single core), it's $15 cheaper than the 1800X, which it almost beats, and on top of that, it comes with a cooler. Can it get any better? Yes!

Disclaimer: from our own experience with multiple 1700s, max overclocks can vary by as much as 400MHz, depending on the chip and motherboard you overclock it on. That said, we managed an additional overclock of 800MHz across all eight cores of our Ryzen 7 2700 – that's a final clock of 4.3GHz @ 1.45V. With a 360mm radiator chilling it, we never saw temperatures rise above 68°C. That's very impressive. We tried edging it up to 4.35GHz, but decided to back off at 1.5V in fear of damaging the chip. In Cinebench R15, that 4.3GHz netted us an awesome 1,911 points, outclassing even the 4.2GHz score of 1,888 from the 2700X.

However, we saw an increase of power draw from the wall under load versus last gen's 1700, from 110W to 141W. But to be honest, 141W of juice from the wall for an eight-core, 16-thread part really does seem like we're splitting hairs. On top of that, temperatures were pretty damn good; at stock, we never saw anything above 45°C.

AMD really has smashed it out of the park with the Ryzen series, and the 2700 is a fantastic improvement over last gen. Whether it's price, performance or overclocking capability, the 2700 hits the mark for the lot. ■ Zak Storey

Verdict

Features ★★★★½
Performance ★★★★½
Value ★★★★★

With mpressive overclock headroom, low temperatures and improved latency, AMD has done it again.

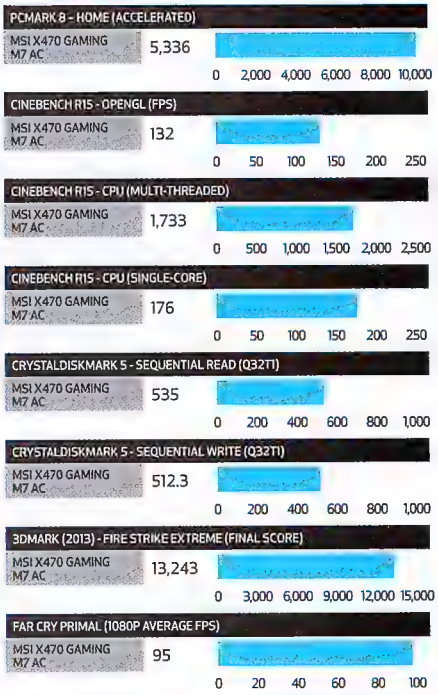
★★★★½

apc RECOMMENDS

MOTHERBOARD

$419 | AU.MSI.COM

LABS BENCHMARK RESULTS


PCMARK 8 - HOME (ACCELERATED)
MSI X470 GAMING M7 AC
5,336
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CINEBENCH R15 - OPENGL (FPS)
MSI X470 GAMING M7 AC
132
0 50 100 150 200 250
CINEBENCH R15 - CPU (MULTI-THREADED)
MSI X470 GAMING M7 AC
1,733
0 500 1,000 1,500 2,000 2,500
CINEBENCH R15 - CPU (SINGLE-CORE)
MSI X470 GAMING M7 AC
176
0 50 100 150 200 250
CRYSTALDISKMARK 5 - SEQUENTIAL READ (Q32T1)
MSI X470 GAMING M7 AC
535
0 200 400 600 800 1,000
CRYSTALDISKMARK 5 - SEQUENTIAL WRITE (Q32T1)
MSI X470 GAMING M7 AC
512.3
0 200 400 600 800 1,000
3DMARK (2013) - FIRE STRIKE EXTREME (FINAL SCORE)
MSI X470 GAMING M7 AC
13,243
0 3,000 6,000 9,000 12,000 15,000
FAR CRY PRIMAL (1080P AVERAGE FPS)
MSI X470 GAMING M7 AC
95
0 20 40 60 80 100

MSI X470 Gaming M7 AC

This premium take on AMD's new X470 chipset fails on the feature front.

Unlike buying a sports car or speed boat, when you spend more on a motherboard, you shouldn't expect to see a substantial performance increase compared to more affordable offerings. Rather, think of it as buying a multi-storey luxury yacht compared to a tinny – while they both zip through the water at the same speed, the luxury yacht is decked out with all the trimmings. That's why boards like this $400+ offering from MSI might not lap the 'boards in this month's X470 roundup (see page 36), when it comes to performance, but you do get quite a lot more for your money when it comes to features.

For starters, these days and at this price range, integrated Wi-Fi is basically ubiquitous, and the M7 AC comes with an Intel Wi-Fi/Bluetooth module on the motherboard. However, it's only limited to 867Mbps, which is outclassed by Intel's newer module that is an optional extra on its budget-series of 'boards, which double the speed to 1.73Gb/s. Still, it's the same speed as other premium X470 boards, and is backed up by Killer's excellent E2500 Gigabit Ethernet chip, which has measurable quality of service (QoS) advantages.

Like the budget 'boards featured in our roundup, this ATX board goes with the relatively standard three PCIe x16 full-length lanes and three more PCIe x1 lanes. Only the top two full-length lanes have steel reinforcement; we expected all three to have been done at this price point. Twin M.2 slots are included, and once again we see the second one is limited to the slower PCIe 2.0 x4 speed.

Both are covered by a singular heatsink that is designed to fit well with the rest of the motherboard's stealthy matte-black design. There's plenty of bling if you want it, though, with more lighting zones than cheaper offerings courtesy of MSI's 'Mystic Lighting' RGB system.

Compared to the ageing ALC892 audio codec seen in this month's budget MSI 'board (see page 40), the M7 AC upgrades this to the newer ALC1220. It's been decked out with higher-quality amplifiers and capacitors, and also includes the Nahimic 3 virtual surround software unique to MSI products.

At this price, you can also expect more features aimed at the tweaking audience, with onboard controls for power, reset and a rotating dial for automatic overclocking. We especially appreciate the clear CMOS and reset BIOS buttons on the rear I/O panel. Speaking of which, this 'board doesn't actually have that many USB ports for the price, with twin USB 2.0, four USB 3.1 Gen 1 ports and just two USB 3.1 Gen 2 ports (one of which is Type-C). Compared to other boards in this price range, we expected more Gen 2 ports. There's not even an HDMI output in case you're running an AMD Ryzen APU, though at this price point, most users will have a discrete video card.

While this motherboard is definitely a step-up compared to its cheaper MSI X470 Gaming Plus sibling, it doesn't quite offer as many extras seen on other premium 'boards, such as more SATA ports, better and more plentiful I/O options or beefed up cooling in the form of heatpipes and large heatfin blocks.

As such, it's not the best 'board around if you're looking to spend over $400 on your Ryzen platform.

■ Bennett Ring

Verdict

Features ★★★★½
Performance ★★★★½
Value ★★★½

This 'board doesn't quite live up to the features offered by other similarly priced X470 premium offerings.

★★★★½

apc RECOMMENDS

35-INCH GAMING MONITOR

$1,249 | AU.AOC.COM

AOC Agon AG352UCG6

AOC heads upmarket.

Picture the perfect gaming monitor: optimised for speed and response, but also practical for daily computing – not some mega-money trinket with features you'll never use, but a screen that hits the sweet spot.

You might imagine a 35-inch panel, with a super-wide 21:9 aspect, a gentle curve, high refresh and frame synching technology. You'd probably also split the difference between maximising pixel density for productivity and putting a cap on pixel count to maintain that crucial frame rate. You would, in short, end up with something that looks a lot like AOC's Agon AG352UCG6. AOC was once known as a purveyor of budget-spec LCD panels.

But that was then. Now, AOC's Agon sub-brand is taking the fight to the likes of ASUS's RoG products and Acer's Predator panels. The AG352UCG6 nails it when it comes to on-paper capabilities. At its core is a 35-inch panel packing 3,440 x 1,440 pixels, courtesy of a 21:9 aspect ratio. That places it an inch larger than the 34-inch form factor that popularised that particular pixel grid. It's also unusual in leveraging MVA rather than IPS panel technology. MVA tends to be strong on colour saturation and contrast, but weaker on viewing angles and response.

The latter is intriguing in the context of this panel's gaming-centric credentials. First up, it supports up to 120Hz refresh. To make the most of that speedy update and guarantee the slickest response possible, AOC has also configured Nvidia's G-Sync tech. Elsewhere, the premium feature set is rounded out by a robust and fully adjustable stand, save for pivot, which is a forgivable omission in a large wide-aspect display. Oh, and the chassis includes rear-firing, programmable mood lighting.

First impressions upon firing up don't disappoint. This panel has a pleasing overall appearance. In fact, it has the subtle feel of an IPS panel, rather than the in-your-face saturation that often signifies VA tech. That said, black levels and contrast are strong points, which is more in line with the typical VA narrative. On the downside, so are the viewing angles. In images used to reveal off-centre colour deviation, this panel can't compete with IPS for image stability when viewed at acute angles. Likewise, when it comes to punch and vibrancy, it's nowhere near the latest HDR or quantum dot monitors.

Another minor niggle involves the 120Hz refresh. By default, the screen only supports 100Hz. Enabling 120Hz requires a trip into the OSD menu to switch on so-called 'overclocking'. This menu is controlled by a single joystick on the bottom of the lower screen bezel, and is very confusing to use. More importantly, it's silly to have to enable overclocking to access what is advertised as a core feature. Presumably, AOC thinks overclocking is cool – which is fine – but should be reserved for modes that fall outside the standard specification.

That said, in testing, the 120Hz capability and its G-Sync sidekick worked flawlessly. Of course, you need a beefy and thus expensive graphics card to make the most of the refresh capability. The panel's 3,440 x 1,440 native might not be as demanding as full-on 4K, but it's still an awful lot of pixels (exactly 4,953,600, to be precise) to push 120 times a second.

Jeremy Laird

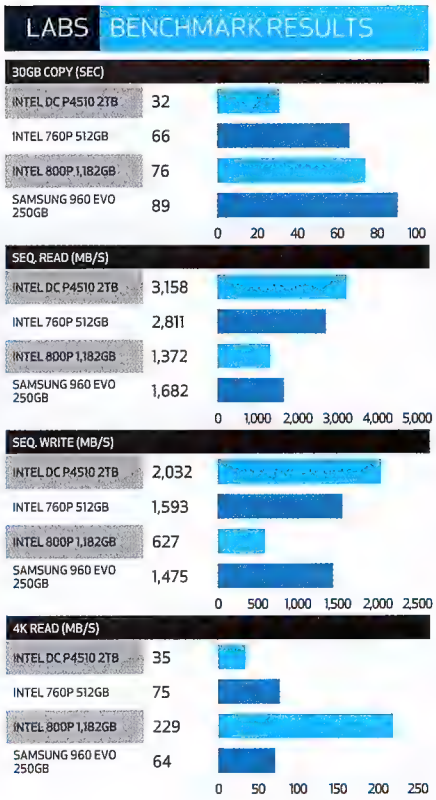
Verdict

Features	★★★★½
Performance	★★★★
Value	★★★★

A pleasing panel with awesome features and a solid build, but not the punchiest picture quality.

★★★★½

apc RECOMMENDS



SSD

FROM $979 (1TB); $1,909 (2TB) AS TESTED | WWW.INTEL.COM.AU

Intel SSD DC P4510

It's like carrying a data centre in your pocket...

Over the past year or two, we've seen Intel roll out new SSDs built into conventional PCI Express cards and SATA enclosures, released in new formats such as M.2, supporting the latest NVMe control protocol in various guises, and even ditching tried and tested NAND flash memory in favour of the radical new 3D Xpoint tech. That's just on the consumer side. Intel's SSDs for servers are even more varied. And yet there's still more.

The 'more' in this case is the new Intel SSD DC P4510 Series. It's available in configurations up to an HDD-besting 8TB, but this example rocks in at 2TB. Still a beefy drive by solid-state standards. Indeed, the smallest of the P4510 Series is a full 1TB.

In many regards, the P4510 looks fairly familiar. The basic form factor is 2.5 inches, and there's 3D TLC flash memory under the hood. But look elsewhere and novelties abound.

Strictly speaking, it's aimed at enterprise applications, such as cloud servers (hence the 'DC' Data Centre monica), but it's still an intriguing device for desktop mortals. It hooks up via the lesser-seen Intel-backed U.2 interface, which seemed like it was set to replace SATA, but that never happened.

Formerly known as SFF-8639, U.2 supports four gen-3 PCIe lanes and the NVMe protocol, and thus matches the more familiar M.2. Indeed, adapter cards transforming M.2 slots into U.2 ports are available. The difference is U.2's cabled interface, with the drive end of the cable looking a lot like a SAS drive connection, and the motherboard end resembling a double-stacked SATA port.

The NAND memory is Intel's 512GB 64-layer 3D TLC stuff, and the NVMe support extends to version 1.2. Within Intel's line-up of enterprise drives, the P4510 falls into the more value-oriented segment, with lower endurance and write speeds than some of its other offerings. Yet it's still very fast in most regards. This 2TB version is rated at 3,200MB/s for reads and 2,000MB/s for writes. Read IOPS weigh in at 637K, while write IOPS are just 81.5K.

For the target market, it's the endurance rating that may be most relevant. Intel rates it at 0.7 drive writes per day (DWPD). Intel's more expensive NAND drives are rated at around 3DWPD, while the fancy 3D Xpoint-powered Optane P4800X is good for 30DWPD. For the record, this is a 15mm U.2 drive, and thus around twice the thickness of a 2.5-inch SATA drive.

How does the P4510 perform? Assessing it fully from a server or cloud perspective is beyond our remit, but as a client drive, the numbers are pretty zippy. Peak sequential performance is very much in line with Intel's claims and random access looks strong, if rather lopsided. But it's the internal file copy that marks the P4510 as something a little bit special: 32 seconds is about half the time taken by a typical consumer M.2 drive, and thus seriously rapid.

Of course, this 2TB SSD is hardly the most cost-effective way of specifying a desktop rig. Almost certainly there are better options. But it does make for a worthwhile reminder of the potential of the U.2 interface, and if the P4510's particular combination of characteristics and capabilities match what would have to be a rather niche set of requirements on the desktop, it might still just make sense. Even for $1,900... ■ **Jeremy Laird**

Verdict

Features ★★★★½
Performance ★★★★½
Value ★★★½

Limited compatibility and not really designed for desktops, but it delivers outstanding performance.

★★★★☆

2-IN-1

FROM $3,399 | WWW.DELL.COM/AU

Dell XPS 15 2-in-1 (9575)

Bigger isn't always better.

Dell has dominated the Windows ultrabook market with its Dell XPS 13 and 15 machines for the last few years, and last year, it debuted a 2-in-1 version of the smaller XPS 13. That 2-in-1 is now also widely admired as one of the better convertibles on the market, so Dell is now trying to take that success across to its bigger 15-inch XPS, with this new 2-in-1 variant using the same design as its 13-inch sibling, with a smooth 360° screen hinge that lets you fold it all the way around into tablet mode.

15-inches is still a bit big and unwieldy for a 2-in-1, but the designers are seemingly hoping to woo more buyers by also making this machine gaming-capable, thanks to a hybrid Intel/AMD processor that has a Core i7 CPU bolted to an AMD RX Vega graphics processor. It's a monstrous chip that does deliver when it comes to performance – but it can get monstrously hot, something which affects this thin-bodied machine in undesirable ways.

The switch to a 2-in-1 design thankfully hasn't compromised how sleek the XPS 15 is – for a device with a 15.6-inch display, it's admirably compact and slim, although its 2.5kg weight (including the 450g power adapter) means you'll definitely feel it when you have to carry it around.

Moreover, despite being understandably a little thicker than its 13-inch counterpart, this new 15-incher has ditch the full-size USB ports in favour of going all USB-C, of which you get four (two are Thunderbolt 3 compliant). There's a reasonably slim USB-C to A adapter plug in the box, although it's worth noting that power is also delivered through those ports, so when you're using the device plugged in, one USB-C port will always be taken up.

This is premium XPS for every square inch, with a first-rate backlit chiclet keyboard surrounded by a delicious soft-touch carbon fibre palm rest, huge and responsive trackpad and a gorgeous 15.6-inch display, that has Dell's super-thin InfinityEdge bezels on the top and sides. That screen comes in 1080p and 4K options.

Performance on this machine is also generally admirable – although you do pay for that in a couple of places. That AMD Vega RX GPU roughly matches the performance of Nvidia's GeForce GTX 1050 – it's an entry-level chip, to be sure, but it will let you play basically all modern games at 1080p on Normal settings at an average of 60fps.

That brings us to the first problem – fan noise, which is near-constant and not just for gaming, but even for just light workloads like surfing the web. Dell does offer a Power Options app that lets you adjust certain cooling settings, but even in 'Quiet' mode, the soft whooshing of fans is still clearly perceptible.

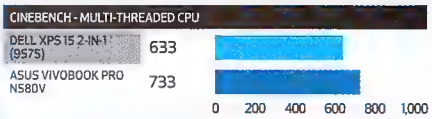
Also middling is the battery life, which for everyday workloads is around 3 hours. That can stretch to just over 5 hours for watching movies, but this is definitely not an 'all-day' machine.

Those two problems don't quite scupper this device's appeal, but they will almost certainly turn some off... Here's hoping that Dell can fix these issues for the next iteration. ■ **Dan Gardiner**

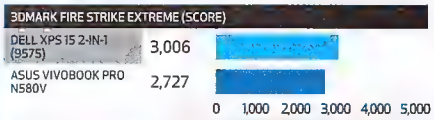
LABS BENCHMARK RESULTS

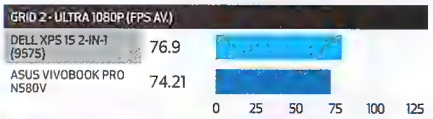
General performance

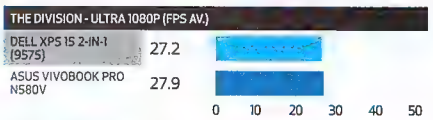
Media encoding performance



Graphics performance







Battery Life

Verdict

Features ★★★★
Performance ★★★★
Value ★★★½

This sleek 2-in-1 still has grunt, but that sadly comes at the cost of high noise and middling battery life.

★★★½

17-INCH GAMING LAPTOP

$5,899 | AU.MSI.COM

MSI GT75 Titan 8RG-096AU

Is the new portable gaming mothership from MSI a genuine titan, or a titanic calamity?

The Titan 8RG looks like it eats other gaming laptops for breakfast. In both specs and looks, this monster seems to have gorged on at least two other gaming laptops to make a massively overpowered rig that's gunning for performance records and your bank account.

At the head of this well fed snake is a new Intel Core i9 CPU, boasting an additional two cores over last year's laptop CPU offering and has clock speeds that push it into the i9 bucket. These chips from Intel happen to also be unlocked, allowing you to overclock the devices to their limit – though with uniform cooling inside, this won't add up to much of a performance boost.

Marry this new CPU with an Nvidia GTX 1080 GPU and an exhaust array to cool these beefy components and you'll start to see why the package ends up at 5.8cm thick. Fortunately, the Titan's ample girth gives it more than enough space to slide a full mechanical keyboard into the mix and while the Blue-like switches will be a little loud for many, the keyboard actually feels much nicer than the Brown switched mechanical array offered on the similarly specced Aorus X9 (over the page). The unit also manages to squeeze in the fastest 512GB SSD we've seen, which reads and writes at 3,503MB/s and 2447.6MB/s respectively, effectively doubling the write speeds of anything we've tested.

The Titan packs in a speedy 17.3-inch, 120Hz IPS display at 1080p, with competition-level 3ms response times. While there is a 4K option available overseas, locally the system defaults to the FHD spec, so you'll have to be willing to sacrifice clarity for cutting-edge frame rates. Combine the new hexa-core i9 CPU with a futureproof 32GB of RAM and you get single- and multi-core Cinebench R15 scores 16% and 23% higher than this year's top Core i7 laptop chips. This translates to some pretty considerable boosts in general work and home tasks. It's also pretty adept at putting the latest titles through their paces, averaging more than 60fps using the highest 1080p settings on almost every game we tested.

While the screen has a good viewing angle, it misses out on the G-Sync capabilities that you get on the Aorus – a considerable concession on a supposedly no-compromise machine.

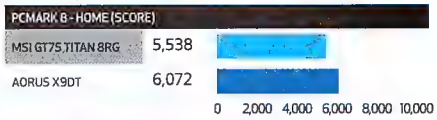
Then there's temperature. The Titan is twice as thick as the Aorus, yet shares much of the same internals, so you'd think this extra space would've been used for thermal management. However, the CPU frequently spiked to 100°C when benchmarking. While this difference in thermal maximum gave a 10% single core boost to the Titan's raw processing performance, it had no noticeable impact on general working tasks and will shorten the overall lifespan of the chip.

In the end, MSI's GT75 Titan is overshadowed by competitors that offer more critical features in a more portable package... and that come in at a lower price too.

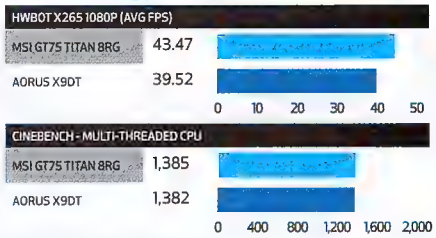
Joel Burgess

LABS BENCHMARK RESULTS

General performance



Media encoding performance


HWBOT X265 1080P (AVG FPS)
MSI GT75 TITAN 8RG 43.47
AORUS X9DT 39.52
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CINEBENCH - MULTI-THREADED CPU
MSI GT75 TITAN 8RG 1,385
AORUS X9DT 1,382
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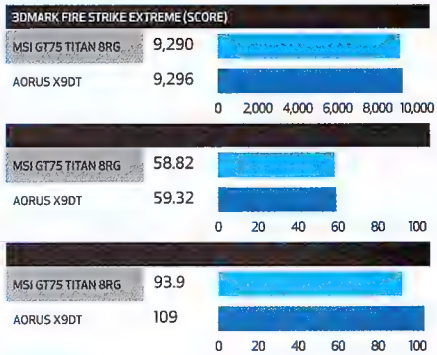
Graphics performance


3DMARK FIRE STRIKE EXTREME (SCORE)
MSI GT75 TITAN 8RG 9,290
AORUS X9DT 9,296
0 2,000 4,000 6,000 8,000 10,000
MSI GT75 TITAN 8RG 58.82
AORUS X9DT 59.32
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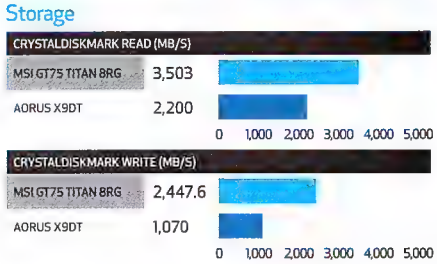
MSI GT75 TITAN 8RG 93.9
AORUS X9DT 109
0 20 40 60 80 100

Storage


CRYSTALDISKMARK READ (MB/S)
MSI GT75 TITAN 8RG 3,503
AORUS X9DT 2,200
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CRYSTALDISKMARK WRITE (MB/S)
MSI GT75 TITAN 8RG 2,447.6
AORUS X9DT 1,070
0 1,000 2,000 3,000 4,000 5,000

Verdict

Features	★★★★½
Performance	★★★
Value	★★★

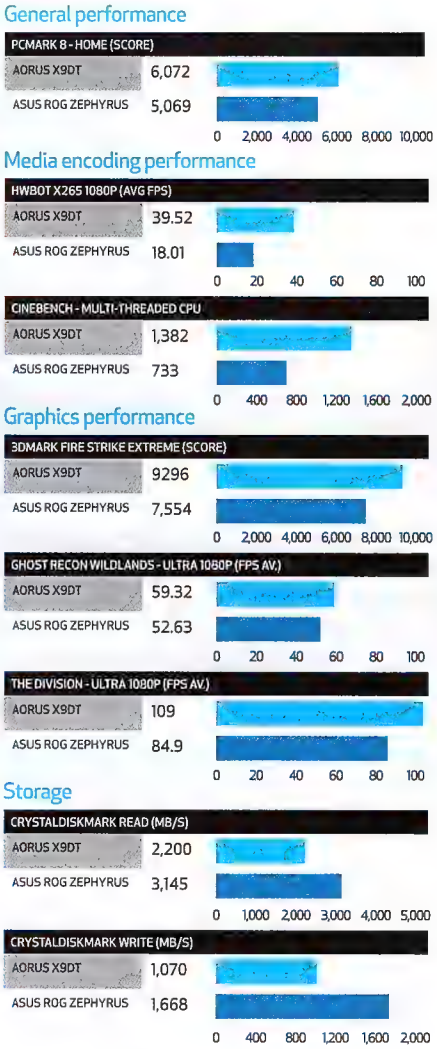
While undoubtedly the biggest ship in the gaming laptop sea, it is outmanoeuvered by its competitors.

★★★½

$5,599 | WWW.AORUS.COM

Aorus X9 DT

Can this 17-incher's sleek design still carry the weight of the most demanding triple-A games?


General performance
PCMARK 8 - HOME (SCORE)
AORUS X9DT 6,072
ASUS ROG ZEPHYRUS 5,069
0 2,000 4,000 6,000 8,000 10,000
Media encoding performance
HWBOT X265 1080P (AVG FPS)
AORUS X9DT 39.52
ASUS ROG ZEPHYRUS 18.01
0 20 40 60 80 100
CINEBENCH - MULTI-THREADED CPU
AORUS X9DT 1,382
ASUS ROG ZEPHYRUS 733
0 400 800 1,200 1,600 2,000
Graphics performance
3DMARK FIRE STRIKE EXTREME (SCORE)
AORUS X9DT 9296
ASUS ROG ZEPHYRUS 7,554
0 2,000 4,000 6,000 8,000 10,000
GHOST RECON WILDLANDS - ULTRA 1080P (FPS AV.)
AORUS X9DT 59.32
ASUS ROG ZEPHYRUS 52.63
0 20 40 60 80 100
THE DIVISION - ULTRA 1080P (FPS AV.)
AORUS X9DT 109
ASUS ROG ZEPHYRUS 84.9
0 20 40 60 80 100
Storage
CRYSTALDISKMARK READ (MB/S)
AORUS X9DT 2,200
ASUS ROG ZEPHYRUS 3,145
0 1,000 2,000 3,000 4,000 5,000
CRYSTALDISKMARK WRITE (MB/S)
AORUS X9DT 1,070
ASUS ROG ZEPHYRUS 1,668
0 400 800 1,200 1,600 2,000

The Aorus range is already the moniker Gigabyte attaches to its most elite gaming laptops, so this top-of-the-range X9 really is the best of the best when it comes to no-compromise portable gaming. The 2018 Aorus X9 might not look markedly different from its 2017 predecessor, there's been a pretty considerable change to the GPU architecture.

The new X9 swaps out the 2017 model's dual GeForce GTX 1070 configuration for a single GTX 1080, which is a concession in raw compute power, but allows the device to sidestep some well-established limitations with SLI GPUs. While the black aluminium exterior, full mechanical Brown-switch keyboard and the unique falcon vent design give the impression that this is a luxurious gaming laptop of the highest order, we were still pleasantly surprised by the consistency of its top-shelf components.

This laptop boasts the first Intel Core i9 CPU for laptops, which not only bumps the upper clock-speed bracket to around 4.8GHz (a 0.9GHz boost on last year's i7-7820HK), but also squeezes an additional two cores into the CPU array, for a total of six. When we say that max speed is "around" 4.8GHz, that's because its Core i9 CPU only gets that fast when overclocked – and Intel actually fully allows that, with the chip unlocked to make it easier. The exact top speed you'll be able to achieve will vary – if you're lucky, you'll get a CPU you can push a little further, but our test X9 was already spiking to 92°C at around 4.6GHz, so there wasn't much room to go further. This isn't really a problem, though, since the X9 still has the most powerful laptop CPU we've seen, breezing past the 2018 Gigabyte Aero 15's Core i7-8750H, with scores about 23% higher on Cinebench R15's multi-threaded CPU benchmarks.

Backing this powerful CPU up is the GeForce GTX 1080 GPU alongside an obscenely generous 32GB of RAM. Combined, those components allow the X9 to run every game we tested at above 60fps when using Ultra settings at 1080p, and even demanding titles like *Far Cry Primal* pushed out more than 100fps.

All this grunt underpins a 17.3-inch IPS display that has a maximum resolution of 1080p. On a pixel count, that's arguably a compromise compared to last year's 1440p, 120Hz TN display, but this new one runs at 144Hz and adds G-Sync to the equation, so on balance, it's actually a better fit for gaming on a laptop.

One component we were surprised to see was a 1TB, third-gen NVMe SSD, which clocked more than 2,200MB/s for sequential read speeds and over 1,000MB/s for writes in our CrystalDisk Mark 6 test. While the write speeds aren't the fastest we've seen from an SSD, they're still twice as fast as any SATA 6Gbps-connected SSD, and you get an entire terabyte of space.

This is also a physically sleek machine and slipping in a full mechanical keyboard, quad-fan cooling system and a GTX 1080 GPU into a sub-3cm chassis is an impressive feat, and one which Aorus is the first to manage. At $5,599, you're undoubtedly paying a premium for this design, but for comparison, the only other device we've seen with these GPU and CPU components (MSI's GT75 Pro, opposite) is 1kg heavier, close to double the thickness, requires two power bricks and has a smaller SSD... It's also selling for $300 more. We know which one we'd choose. ■ **Joel Burgess**

Verdict

Features	★★★★★
Performance	★★★★★
Value	★★★★½

Combines great components to deliver the one of the most impressive portable gaming experiences available.

★★★★★

MESH NETWORKING KIT

$449 (SET OF THREE) | WWW.DLINK.COM.AU

D-Link Covr

Get meshed for less.

As we've repeatedly seen in the last few big *APC* networking round-ups, mesh router kits are a neat way to solve the problem of getting good Wi-Fi across a large space, although they do come at quite a cost. Kits that include three wireless 'nodes' can set you back upwards of $650, so D-Link is seriously undercutting that with its new 'budget' three-node offering at only $450.

Of course, there's a couple of catches associated with that – the set's only rated for AC1200 speeds, for example, meaning connection speeds max out at 867Mbps on the 5GHz band and 300Mbps on the 2.4GHz band. Admittedly, that should still be enough for most households, even with a couple of dozen wireless devices connected.

To their credit, the Covrs are very easy to set up – just connect to the first node via Wi-Fi and follow a few quick steps, like setting a wireless network name and password, and entering your ISP login details, then plug the additional nodes into the back of that first one (one at a time) via Ethernet, wait about a minute, then unplug and place that 'satellite' node where you need it. It's a bit more efficient than the traditional approach, which is to connect and set up every node individually via Wi-Fi.

On the downside, that simplicity also extends to how configurable the set is. Jump into the Wi-Fi settings, for instance, and you'll find it can't really be switched off auto-sensing mode when it comes to making connections – there's no way create separate dedicated 2.4GHz and 5GHz channels, or turn one of the others off entirely if you don't want to use it. You can change the network's SSID and password, but that's about it.

Likewise, it has both parental controls and quality-of-service (aka 'traffic prioritisation') services. The former allows you to fill out a list of websites you'd like blocked and specify which devices they're blocked on, while the latter lets you use a drag-and-drop interface to give specific devices higher or lower priority – each, basically, is the bare-minimum you'd expect for that feature category. This is not one for the tinkerers, then.

The Covrs do live up to their name, however – thanks to the three provided nodes, we were indeed able to achieve excellent coverage across the 80m² apartment we tested in, with wireless internet connectivity available across every square inch and not a dead-spot to be found.

However, we did find that transfer speeds across nodes were a little lacklustre – something that's likely to blame on the lack of a dedicated 'backchannel' for those nodes to communicate with each other. This meant that, while transfer speeds for two devices on the same node are fine, if you're trying to do something bandwidth intensive that jumps across the nodes, you'll see speeds drop significantly the further apart those nodes are. That means wireless speeds ranged between 55MB/s to 15MB/s and were more erratic than in mesh kits like Linksys's Velop and Netgear's Orbi (both of which have a dedicated backchannel).

If you just want to get internet to every nook and cranny, that variable speed probably isn't going to be an issue – it was always above what a 100Mbps NBN connection can download at. On the other hand, if you want to do more demanding activities that rely on a lot of local bandwidth, like, say, streaming games from your desktop PC to the TV in the lounge room via Steam, you'd be much better served by a mesh kit with a dedicated backchannel.

Dan Gardiner

Verdict

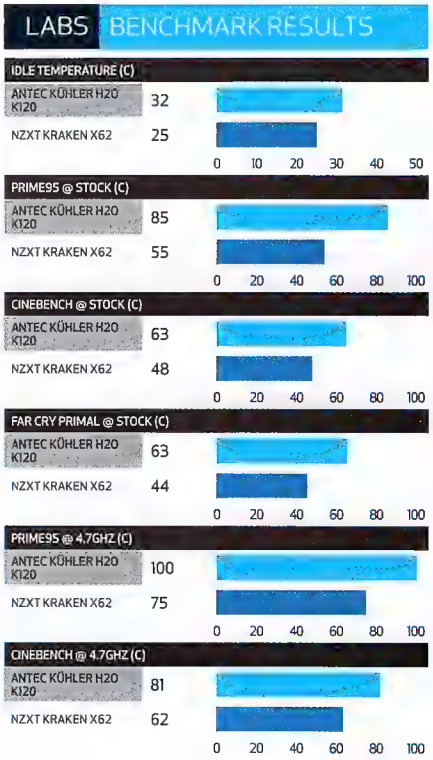
Features	★★★½
Performance	★★★½
Value	★★★★

These will provide good connectivity, but struggle with local network speeds and the depth of configuration options.

★★★½

AIO COOLER

$65 | WWW.ANTEC.COM


LABS BENCHMARK RESULTS
IDLE TEMPERATURE (C)
ANTEC KÜHLER H2O K120 32
NZXT KRAKEN X62 25
0 10 20 30 40 50
PRIME95 @ STOCK (C)
ANTEC KÜHLER H2O K120 85
NZXT KRAKEN X62 55
0 20 40 60 80 100
CINEBENCH @ STOCK (C)
ANTEC KÜHLER H2O K120 63
NZXT KRAKEN X62 48
0 20 40 60 80 100
FAR CRY PRIMAL @ STOCK (C)
ANTEC KÜHLER H2O K120 63
NZXT KRAKEN X62 44
0 20 40 60 80 100
PRIME95 @ 4.7GHZ (C)
ANTEC KÜHLER H2O K120 100
NZXT KRAKEN X62 75
0 20 40 60 80 100
CINEBENCH @ 4.7GHZ (C)
ANTEC KÜHLER H2O K120 81
NZXT KRAKEN X62 62
0 20 40 60 80 100

Antec Kühler H20 K120

Small, quiet and affordable, but not for overclockers.

There's a lot going for the latest all-in-one from Antec. It looks good, it's easy to install, it's affordable, and it runs quietly, but this is balanced by its performance, which is... well, nothing too exciting, to be honest. It'll keep your stock-clocked CPU off the 'Tj Max', but anyone interested in pushing their processor harder is going to want something a bit bigger. We're getting ahead of ourselves here, though, and it's worth dwelling on what Antec's latest cooler does well, because it's actually a great bit of gear.

The problem with many AIO coolers is they need a lot of room. At least, that's the perception. This can be the case in some older chassis, but every modern case we've looked at recently can accommodate at least a dual-fan radiator and triple-fan rads aren't completely out of the question, even in smaller cases. Still, there are times when you want a compact AIO to take the edge off your processor, and this is where the Antec Kühler H20 K120 saunters in, with its blue-lit fan (it only lights up under load) and budget price tag.

Antec has shifted the water pump away from the top of the CPU block and instead installed it into the radiator, which means that the CPU block is thinner than what you may be used to (it's well under two inches thick). This has the side effect that there are no unwanted vibrations on the CPU itself, which could, in theory, lead to the block working itself loose or, worse, damaging your CPU or motherboard (although we've never experienced this, or heard of anyone suffering from it).

Installation of the K120 is one of the easiest experiences we've had with an AIO, thanks to its tool-free design. The supplied backplate supports AMD and Intel chips, depending on which way around you install it, and there are bolts that work for all the major sockets, including AM4, LGA 2011 and LGA 1151. Some fairly high-end hardware, in other words.

For the Intel Core i7-6700K we use for testing, the installation was particularly pain-free. Slide the bolts into the backplate, screw the offsets into place, clip the bracket over the CPU block, then use the thumbscrews to hold it in place. The fan screws easily on to the radiator, although you need a screwdriver for this job, and for attaching the radiator to your case. Still, it takes mere minutes to install.

All good, then? Mostly, yes. The installation is impressive — no doubt about it — but when it comes to cooling, the K120 is held back by its size. The Core i7-6700K isn't a cool chip, but it was hitting high temperatures at stock speeds (85°C in Prime95), and once we overclocked it to 4.7GHz, we found ourselves knocking on 100°C. That's seriously hot. If you're looking for an AIO cooler for your overclocking exploits, we'd recommend looking at something bigger, such as the NZXT Kraken X62.

The counter to these somewhat toasty temperatures is that the K120 is a quiet cooler. Indeed, the PWM fan tops out at 1,800rpm, and even then is barely more than a whisper at 30dBA. The other point in the positive column is the price. At just $65, this is one of the more affordable AIOs around, making it a great cooler for any budget build where noise is to be avoided, and you're not bothered about overclocking. ■ **Alan Dexter**

Verdict

Features ★★★★½
Performance ★★★½
Value ★★★★

This affordable, quiet and compact AIO is easy to install, but it's not the coolest, and it struggles with overclocking.

★★★★½

apc HOT PRODUCT

PC CASE

$115 | WWW.COOLERMASTER.COM

Cooler Master MasterBox MB500

What's cooler than being cool? Being cheap, too, obviously!

You couldn't ask for more than what this budget-end case provides. Five years ago, a case with three RGB fans and a tempered glass panel would be considered wildly opulent, and priced accordingly. And now, here we are, in the age of flossing, Fortnite and Facebook scandals, staring a budget case in the face with those very features.

It's easier to put together a low-end gem when you've been putting in the design graft on higher-end models like the venerable HAF X, and iterating on those solid foundations for years, than it would be to devise a solid chassis from scratch. There's not much HAF X DNA visible in the aesthetics of this MasterBox MB500, but the fundamentals of good airflow, easy access, and solid build quality are definitely present and correct.

For a mid-tower, the clearances are all ample: 16cm for CPU coolers, 39.9cm for GPUs and 17.8cm for the PSU, which lives in a generous self-contained module at the base, and has plenty of space for tidying cables away. Even using a non-modular power supply with several extraneous cables, it's easy to keep things neat by using the PSU enclosure. We did miss having a hole in the back panel to feed a CPU power cable through, and instead had to make a tight connection across the board face, but this is the only concession to the MB500's smaller size and less feature-rich design. There's support for just two 3.5-inch drives or three SSDs, located at the base beyond the PSU enclosure.

It's pretty plain sailing inside, with plenty of space to screw components in and make cable connections lower on the motherboard, despite just two holes at the side and one below the board. There's a generous space between the motherboard mounting panel and the removable side panel, which means you don't have to go crazy with the cable ties in order to achieve a neat look and good airflow. Just stuff unwanted cable lengths out of sight at the rear and it's job done.

The plastic finish at the front proved divisive in the office, but the two RGB fans lurking behind the facade, along with one at the rear, are a nice touch for those who like every component and peripheral in sight to be colourfully synched. These can be hooked up to ASUS, Gigabyte and MSI RGB boards, and tweaked using each manufacturer's software suite to apply the right (read: wrong) shade of wedding-disco lighting. In terms of finish quality, there are minimal rough or sharp edges inside the case, and our only real complaint is that the tempered glass side panel doesn't sit quite flush with the case.

We're at a loss as to why someone *wouldn't* pick this for their budget or even mid-range build. After all, it always makes sense to spend more on the bits inside the case and go a tad frugal with the exterior – not that lit fans and glass panels are all that frugal... Unless you really need more than three drives installed, this should be your first consideration for a budget PC case. ■ **Phil Iwaniuk**

Verdict

Features	★★★★☆
Performance	★★★★½
Value	★★★★★

The MasterBox is amazing value for money, easy to build in and with a smart finish. Just note its two-drive capacity.

★★★★½

software

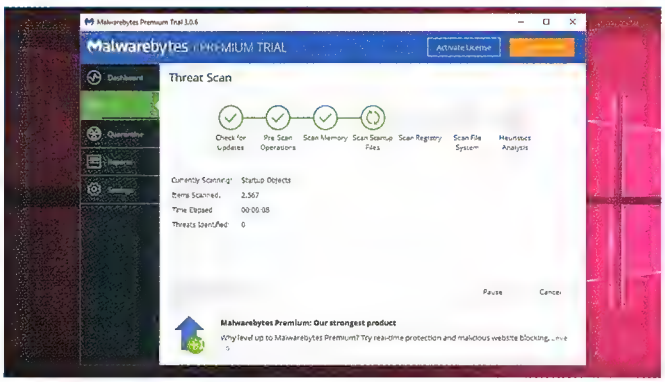
» APPS FOR ALL THE PLATFORMS

Windows SOFTWARE

Malwarebytes for Windows

Detect and remove the malicious software your antivirus suite misses.

FREE; PREMIUM FROM $60 PER YEAR | WWW.MALWAREBYTES.COM



Potentially unwanted programs and other kinds of malware are a real threat if you like downloading and experimenting with free software. Sometimes when you download a program, an unwanted extra comes along for the ride, and while you're antivirus suite should weed out all the malware, often the additional bloatware isn't technically a virus, so it's unlikely to be picked up by your PC's screening system.

Nevertheless these applications can be just as annoying, redirecting your homepage, changing your default search engine, adding toolbars to your browser, placing sponsored links on your desktop, and generally making your PC life miserable. Unwanted applications can even go so far as to compromise your privacy, by monitoring your comings and goings, then reporting back to advertisers.

Malwarebytes is particularly good at finding and erasing these potentially unwanted programs (PUPs), but it's also adept at wiping out more serious issues, including ransomware. It won't replace your usual antivirus software, but it a superb addition to your online security arsenal.

When you first install Malwarebytes, you'll be given a 14-day free trial of the premium edition, including real-time scanning. Once that expires, you'll have to open the program and scan for issues yourself, but this is easy and well worth the effort.

Although Malwarebytes is designed to work as a supplement to your regular antivirus software, not a replacement, it's worth quickly checking the official forums to see if there are any known conflicts.

During scans, Malwarebytes checks your PC's memory, startup files, registry and file system – a comprehensive search that should pick up any dangerous programs that are currently running, or ready to launch themselves next time you reboot your PC. It'll take some time, but is really something you should consider doing – either as part of routine maintenance, or if you've noticed your PC or web browser behaving strangely.

The detection rates are excellent, and if you do find yourself performing manual scans on a regular basis, it's definitely worth considering an upgrade to the premium version.

Cat Ellis

7-Zip

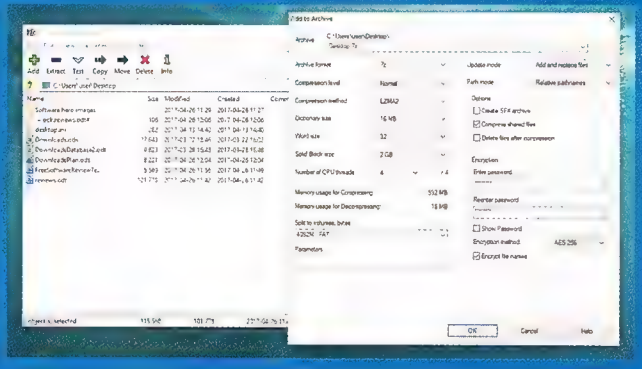
The ultimate free tool for zipping and unzipping file archives

FREE | WWW.7-ZIP.ORG

7-Zip's remit is simple: it compresses and decompresses files. Two key reasons you'll need a file zipping app are the internet (compressing files means they can be sent and received faster) and security (compressed files can be encrypted and password-protected).

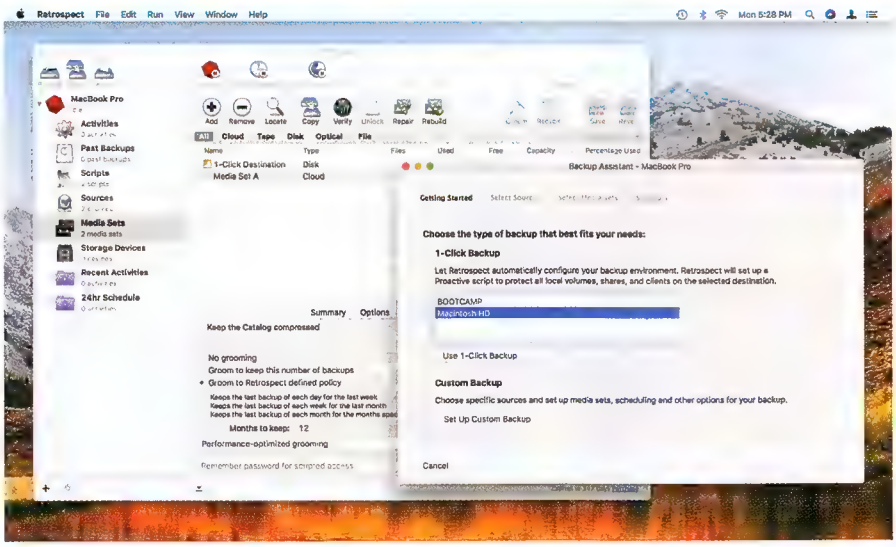
There is also software out there that requires multiple files to be zipped into the same folder in order to read information, so you never really know exactly when you're going to need one, but there's a good chance you will.

7-Zip is free, fast and tiny. As well as the all-important ZIP format, there's support for the creation of numerous other types of compressed file including 7z, BZIP2 and TAR. The fact that ZIP and RAR files are covered is reason enough to install 7-Zip right away, but this software offers support for a seriously lengthy list of decompression formats.



7-Zip's file manager interface is a little confusing, so it's often easier to just use the context menu that'll pop up in your options when you right click a file in the manager.

Mark Wycislik-Wilson



Retrospect Solo 15

Back up your Mac to more places.

US$49 | RETROSPECT.COM

The release of Retrospect 15, which can back up your Mac to directly attached drives, networked storage and cloud services, includes a new edition. As the 'Solo' in its name suggests, it's the one to pick if you have just one Mac to back up and want something better than Time Machine.

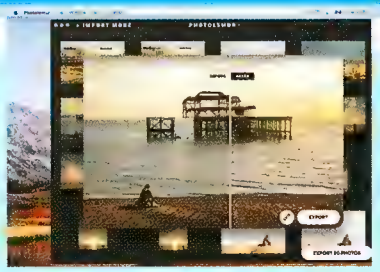
It uses the same interface as other versions, including the useful summary page, which confirms recent activity, how much data has been backed up, estimates the space you'll need this week and month, and more. Backup options are comprehensive, including two levels of file verification, password-protected encryption, and catalogs you can search even when the corresponding media is unavailable.

A highlight of this (and Retrospect 15 in general) is email protection to back up the contents of IMAP-connected email accounts to local or other cloud storage.

There's a wealth of help online, though getting familiar to know you've set things up correct is inevitably more time consuming than with alternatives designed for consumers.

Retrospect Solo 15 is a powerful and great tool if you're self-employed and can invest time in researching its many features.

Alan Stonebridge



Photolemur

AI takes on photo editing.

FROM US$35 | PHOTOLEMUR.COM

"Simplicity is the ultimate sophistication", goes the saying, so how about this: a photo editor which uses artificial intelligence (AI) to make your photos look their best. The interface is simple — a small window onto which you drop one or more images. After a few moments (Photolemur carries on processing in the background if you import a batch), you're presented with an almost non-negotiable result — you can drag a vertical slider across your image to preview your shot before and after, while a slider lets you vary the strength of the changes.

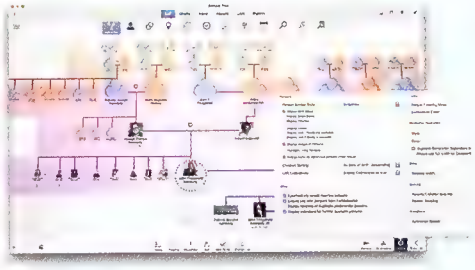
On fundamentally sound RAW files, Photolemur showed a light touch. Slightly brighter highlights, gently increased saturation and a touch more clarity all produced nice-looking, ready-to-print images. Even on ropier images, there's a marked improvement. Purists will prefer apps with more fine-grained control, of course, but if you don't mind technology taking the wheel, Photolemur's results are easily up to snuff. Basically, Photolemur will definitely improve your images.

Dave Stevenson

MacFamily Tree

Geneaology on the Mac is now slicker than ever.

US$60 | SYNIUMSOFTWARE.COM



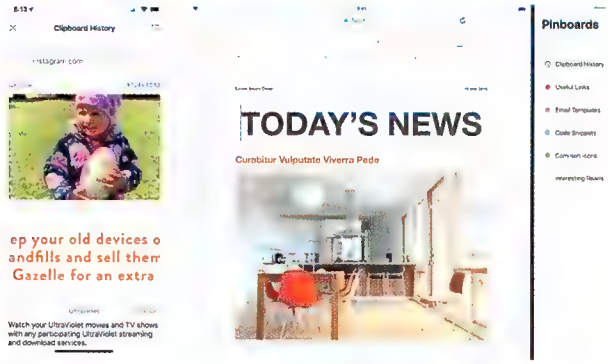
When it comes to Mac genealogy solutions, nobody does it better than Synium. Version 8.3 of MacFamilyTree dramatically improves performance, especially while working with the Interactive Tree. This is our favorite way to edit a family tree and the adoption of Metal 2 support allows for smoother animation and improved text rendering.

Interactive Tree benefits from other improvements, notably the ability to hide the sidebar for viewing across the entire window width. Generation separator options make it easier than ever to see who's related at a glance and, at last, users can print a hard copy of their tree.

Vsuals have been improved across the board. Bloodline and indirect relationship paths including adoptions have been added as display options, along with six Timeline styles that offer a fresh look at tree data. Other new features include duplicate detection and merging two different GEDCOM or MacFamilyTree databases.

You'll need a recent Mac, capable of running macOS 10.13 High Sierra, though, and at least macOS Sierra is required for CloudTree support, which allows real-time collaboration.

■ **JR Bookwalter**



Paste 2

Simple clippings management.

FREE WITH IAP | PASTEAPP.ME

Apple's Clipboard seamlessly copies and pastes between Mac and iOS, but the current implementation falls short. Instead of simple one-time data transfer, a true clipboard manager would enable saving and organising frequently used clippings.

After making a splash on the Mac three years ago, Paste 2 has arrived for iOS, giving power users exactly what they've craved all along. This free mobile app uses iCloud to sync text, images, links, files or other content saved with Paste for Mac 2.3 or later – and vice versa – organising clippings into folders called Pinboards.

You can rearrange, delete, rename or share snippets, but there's no way to directly add new content into the iOS app – this must be done from other apps like Safari or Mail via the sharing extension. The process is as straightforward as it sounds, and a share sheet prompts you to give the clipping a unique name and file it in an existing Pinboard.

Like the desktop version, Paste 2 for iOS features a similarly sparse, clean user interface. Clipboard History consolidates everything into a single searchable Pinboard, and the developer includes a second Pinboard for Useful Links with website and support contact information. It's a snap to add new Pinboards, each tagged with a colour of your choice, but this can only be done from the main app, not via the sharing extension.

Tapping the three-dot menu button in the upper right corner enables you to manage Pinboards or app settings. There are only three toggle switches for the latter, which enable or disable copy on app activation, copy on widget activation, and iCloud sync. The second option pastes the current clipboard contents whenever you switch to the Paste widget, which can be easily expanded to display the last seven history items.

Paste 2 for iOS also includes native support for iPad, with one caveat – adding or syncing Pinboards on a tablet requires a one-time in-app purchase of $7.99 for what the developer calls a 'Pro' upgrade. It's hard to complain given the core app is free to begin with, but the decision to effectively handicap only the iPad version is disappointing. **JR Bookwalter**

Scanner & Fax Pro

A mobile scanner and faxer

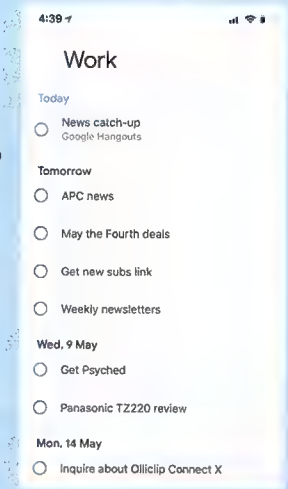
FREE TRIAL; $140 YEARLY SUB | BIGFISHAPPS.ME

Scanning apps are fairly common these days, what with Apple's native Notes app offering a very capable feature that does just that. Unfortunately, there are still some services out there (cough, the Australian public health system) that insists on being sent faxes. Yes, *faxes*. So there's definitely a need for a service such as this for those of us who don't have a fax machine. Scanning the doc is simple enough, although the 'auto capture' feature is a bit eager, meaning you'll take several accidental images before you steady your phone. After discarding the blurred ones, you can edit the image by brightening it up, rotating, making it black and white, and cropping before saving. It can also digitise the text on the document and convert it into a simple text file. (Although, obviously, formatting is lost.) Once you're happy with the image, you can email it, save to Drive, fax it and other useful options. Faxing is a simple matter of selecting the country, entering a fax number and the name of the recipient, then hitting send. If you need the ability to fax on the go, this is a stress-free way to do it. The only downside is the cost. You'll have to cough up $13.99 for a single month after the three-day trial is up, or $139.99 for a full year (which is actually comparable to other online services). So while you'd have to be a very heavy fax user to see the value in this, sometimes... you may not have a choice. **Carmel Sealey**

Google Tasks

A bare-bones attempt at yet another to-do list.

FREE | GOOGLE.COM



Alongside the redesigned Gmail, Google launched a standalone to-do app called Tasks. It's available on iOS, Android and on desktop and, more importantly, is accessible via the new-look Gmail and Google Calendar. While there are plenty of to-do apps out there, Google has stripped Tasks down to the bare bones, giving it a clean, crisp UI that lists all your tasks in one place. And that's it. There really isn't much more to the app. You can set up sub-tasks for each item — like adding a shopping list to 'buy groceries' — and can create multiple task lists and switch users if you have multiple Google accounts, but you can't set up alerts or share the lists with others. While you can add a date for a task, you can't specify a time. Perhaps Google decided less is more, but this time, less is definitely less, especially when there are more sophisticated to-do apps available for free. That said, there may be scope for improvement, if Google is willing to add more features to Tasks. **Sharmishta Sarkar**

Google Play » ANDROID

en.m.wikipedia.org/wiki/Nucl
WIKIPEDIA
Nuclear warfare
"Nuclear War" redirects here. For other uses, see Nuclear War (disambiguation).
"Atomic war" redirects here. It is not to be confused with Atomic Wars.
"Nuclear strike" redirects here. For other uses, see Nuclear strike (disambiguation).

Opera Touch

A radio app which prizes simplicity in design.

FREE | OPERA.COM/MOBILE/TOUCH

Can Google Chrome be dethroned as the most popular web browser in the world? Given its dominance (it hosts nearly 58% of all web traffic counted in April 2018 by StatCounter), one would assume not. It doesn't hurt to have alternatives, though, and veteran web browser company Opera Software has just issued a pretty decent one by the name of Opera Touch.

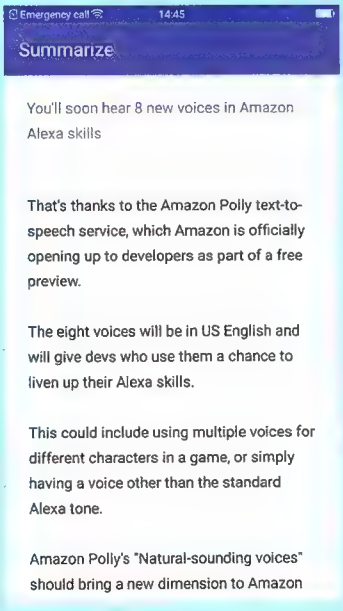
Given the Opera browser pioneered features we now take for granted – such as pop-up blocking, private browsing and tabbed browsing – it's a typically pleasant user experience. The novelty here is that using a one-time QR code setup between a phone and a computer, you can easily push webpages between devices with a single button press. Not only that, but you can add images, videos and text to your 'Flow', which is a kind of personal cloud service available between desktop and phone versions of Touch – it's a genuinely useful function. Aside from that, there's a fixed menu button at the bottom centre of the screen which brings up functionality supporting text, image and voice search. It's hard to imagine Opera retaking the browser market in any mainstream sense, but that doesn't mean you shouldn't start using it. **Shaun Prescott**

Summarize

Getting to the point

FREE | TINYURL.COM/APC456-SUMMARIZE

Apps that can summarise the news have been around for a long time, though their elegance and beauty is sometimes overshadowed by the amount of stuff they throw at you. Flipboard looks great, but if you really want to laser in on an article, there may be a better way. Summarize makes a decent go of this and is singular in its approach. It's still in early access, but the results are promising. The interface is clean, as it strips out images and provides text alone, distilling the essence of the piece you're reading into a few paragraphs. Summarize copies some of the source wholesale, other paragraphs are stitched together with neighbouring copy, while some are small fragments of the original. Summarize's interface is clean, and for the most part, it gets the guts of the story. However, you lose almost all of the colour and background, and the app only works after you've shared a link to it from your web browser. **Paul Taylor**

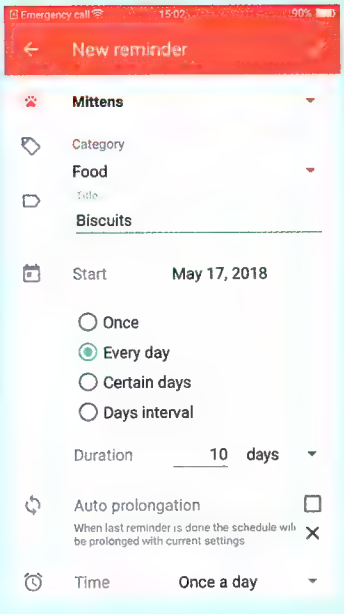

Emergency call 14:45
Summarize
You'll soon hear 8 new voices in Amazon Alexa skills
That's thanks to the Amazon Polly text-to-speech service, which Amazon is officially opening up to developers as part of a free preview.
The eight voices will be in US English and will give devs who use them a chance to liven up their Alexa skills.
This could include using multiple voices for different characters in a game, or simply having a voice other than the standard Alexa tone.
Amazon Polly's "Natural-sounding voices" should bring a new dimension to Amazon

Pet's Diary

Are you feline the love?

FREE | TINYURL.COM/APC456-DIARY

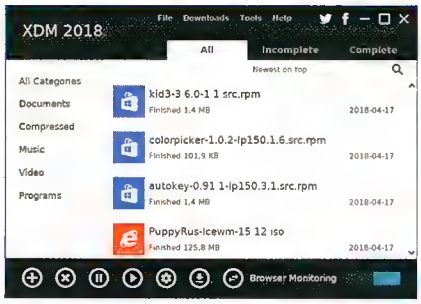
Got pets? Great. So far you've probably managed to not kill them by sheer virtue of feeding them. It's a good start. But do you know when you last had them vaccinated, or when they had their litter of pups, or even their menstrual cycle? Although your smartphone already has a calendar built into it to record such events, Pet's Diary is a more bespoke and less cluttered way to note 'feed Mittens dry food' than jamming that reminder next to 'buy milk' on your Google Calendar. From the menu, it's easy to set an upcoming and repeating reminder, items to buy in different categories like food, toys or life events and so on. You can then search for these in the history tab in case you get the stink eye from the vet asking you when you last gave Mittens her worming tablets. It's simple stuff, but easy to read, and while it's a shame that you can't share your schedule with someone else, it's pretty handy nontheless. An ad-free version costs $4.02. **Paul Taylor**



XDM

A speedy dedicated download manager.

FREE | SOURCEFORGE.NET/PROJECTS/XDMAN



If you've come to the conclusion that standard web browsers' download managers don't meet your needs anymore and you should go with a dedicated download manager, then it probably means that you download a lot of stuff from the web and wish you had a faster connection.

Naturally, there's a lot to choose from for a Linux user and everyone can go with a program of their choice. This is why we were particularly suspicious to read that eXtreme Download Manager (XDM) provides "up to five times faster" download rates. How can it be possible? We conducted a few field tests and discovered that, while XDM certainly couldn't work wonders with our regular Ethernet connection, it still downloaded files noticeably faster than any web browser.

XDM is an open-source Java-based program, and you're free to dive into its code and find out what exactly happens under the hood. XDM uses a sophisticated dynamic segmentation algorithm, data compression and connection reuse to speed up the download process – and it really shows. Despite a somewhat ugly user interface, XDM is still a very reasonable choice for those who suffer from poor internet connection speed and/or quality.

As well as faster download speeds, XDM has some features that make it a well-rounded program. These include browser integration plugins for Chrome, Firefox, Vivaldi and Opera, a built-in video downloader with support for YouTube, Vimeo and Facebook, a media convertor, a schedule manager and more.

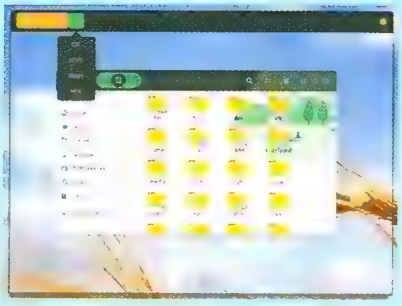
Once you copy a direct link to a file and press the + button, XDM pastes it in the pop-up dialog, so all you need to do is hit OK. XDM can capture streaming videos, convert video clips to audio-only MP3 tracks, run a specified command after finishing all downloads and do some other convenient tasks. Clunky interface aside, this is a program that delivers on its promises.

Alexander Tolstoy

Peek

Record your GIFs.

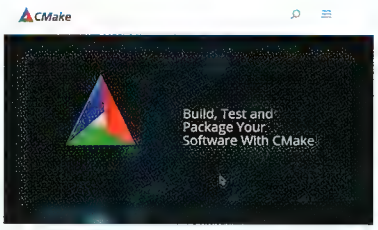
FREE | GITHUB.COM/PHW/PEEK



Saving your screen activity as a GIF is Peek's primary feature. This is a compact piece of software that's designed to do one simple task, and it's very efficient and easy to use. Peek is designed to record specific rectangular parts of your desktop (it can't capture the full monitor), so you may want to use it for guides and manuals that will benefit with a narration. The Peek window is mostly transparent and looks like a frame with a header bar, which in turn hosts only the 'Record as...' button and a tiny drop-down menu. The application enables you to choose from the list of supported output formats, which includes MP4, WebM, animated PNG (APNG) along with GIF.

So a typical workflow is to adjust and place the Peek's window frame, press the Record button, take a deep breath and perform actions that you want to record. When you hit Stop, the program will give you the chance to choose a destination directory where you want to place your recording.

Generally, we found that Peek worked very smoothly and we also appreciated its wide availability, including Ubuntu PPA, Flatpak and Appimage bundles, coupled with comprehensive instructions for the installation. **Alexander Tolstoy**



CMake

A software build tool.

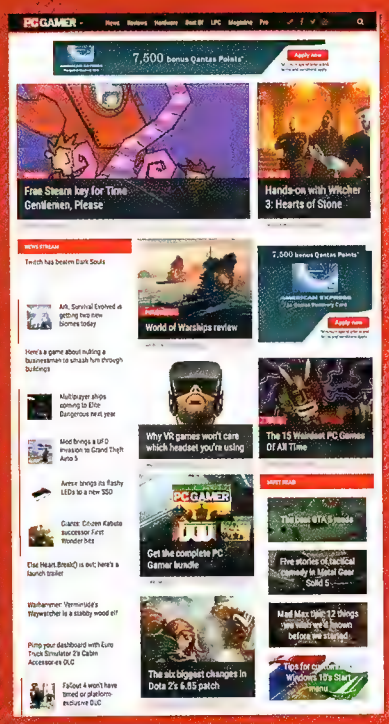
FREE | WWW.CMAKE.ORG

When there's no easy way to instantly grab a precompiled binary package or copy-paste a few commands into your terminal, you may be advised to build the software from sources — a task for advanced users. CMake is a tool that makes compiling a source code more manageable for all. Developers often employ it to package and test their code, whereas other mortals use it to create a Makefile and then compile it to ready-to-use software. That said, sometimes, every other bit of software we recommend has a source tree with a CMakeLists.txt file, meaning that you'll need the `$ cmake` command to compile the code. CMake is flexible and offers decent backward compatibility thanks to its modular structure. New CMake features are commonly introduced via so-called policies that you can enable or disable using CMake command arguments. In real-life usage, it means that if you try to build older code with a newer CMake version or vice versa, you'll see lots of warnings, but the code will most likely compile without problems. Here's a typical CMake command sample to get you going:

```
$ cmake -DCMAKE_INSTALL_
PREFIX:PATH=/usr -DCMAKE_
INSTALL_LIBDIR=/usr/lib64
..
```

We added an extra argument to tell CMake to use the system-wide /usr prefix and put shared libraries inside /usr/lib64. The two dots at the end indicate that we're working in a subdirectory inside a main source tree. The result of a successful CMake run is a working Makefile, which you can use to build a program. The latest version of CMake runs more parallel threads when configuring sources, and thus performs faster than ever. ■ **Alexander Tolstoy**

SMARTER COOKIES ENABLED


PC GAMER
7,500 bonus Qantas Points
Free Steam key for Time Gentlemen, Please
Hands-on with Witcher 3: Hearts of Stone
World of Warships review
Why VR games won't care which headset you're using
The 15 Weirdest PC Games Of All Time
Get the complete PC Gamer bundle
Five stories of tactical comedy in Metal Gear Solid 5
The six biggest changes in Dota 2's 6.85 patch

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Ryzen for the masses

AMD's second-gen Ryzen X470 boards can offer stacks of features for not a lot of dosh. Bennett Ring compares four more affordable options.

In last month's mag, we took a deep dive into AMD's latest CPU architecture, the Zen+ design which lies at the heart of its newest Ryzen CPUs (see page 47). At the same time, we also checked out four high-end boards using AMD's accompanying new chipset, the X470, with prices in the region of $400 or so. This month, we're taking a look at the more affordable end of the range of motherboards designed for release with the updated Ryzen, and unlike Intel, you'll be surprised to see the chipset at the heart of these boards.

Despite most of the motherboards in this month's roundup being priced below $300, they all still use the X470 chipset, which is AMD's flagship chipset for the Ryzen. This means it comes complete with all of the features that Intel usually locks off to its more expensive Z370 platform, with the main difference being overclocking. To overclock an Intel CPU, it must first be a K-model chip. Secondly, tweakers have to buy a Z370-based motherboard. If they go for Intel's new H370, B360 or H310 chipsets, which are aimed at more affordable platforms, the ability to overclock has been removed. This goes for both the CPU and the memory, while AMD's X470 chipset retains both.

However, Intel's new budget-chipsets have a rather spiffy new feature in their inclusion of integrated Intel Wireless-AC support, which allows motherboard makers to include the new Intel 1.73Gb/s Wi-Fi module.

> "It comes complete with all of the features that Intel usually locks off to its more expensive Z370 platform, with the main difference being overclocking."

Note that this additional Wi-Fi support is optional, so will cost more if included in the motherboard bundle. On the flipside, the number of USB ports drops on each Intel chipset as they become cheaper, with the H370 having up to six USB 3.1 Gen 2 (10Mbps) or ten USB 3.1 Gen 1 (5Mbps) ports, while the most affordable H310 only has four USB 3.1 Gen 1 ports. In comparison, the X470 loses out to the H370 in this regard, as it only has support for up to two USB 3.1 Gen 2 ports or six USB 3.1 Gen 1 ports. The X470 chipset also offers up to eight SATA 3 ports, though most 'boards will only deliver six to save on the number of PCIe lanes used. Intel's offerings all deliver six as the default, with the exception of the H310, which only has four.

We tested the following four motherboards with the Ryzen R7 2700X with twin sticks of G.Skill 8GB memory running at 2,933MHz. This month sees the introduction of a new video card, though, as our last sample died – now we're using ASUS's top-of-the-line GeForce GTX 1080 Ti Strix Ultra. We also installed all of the latest Windows updates, chipset and GPU drivers, and BIOS versions as of May. As a result, the benchmark results from this month's roundup aren't comparable with last month's. But we can happily say that the budget X470 'boards are basically identical in performance at default speeds when it comes to the more expensive options. They manage to cut price by trimming back features such as Wi-Fi, superior overclocking support via better power phase configurations, lower quality audio and fewer I/O options.

Mastering your memory

One issue that still remains with the X470, and was also present on the X370, is that we found every motherboard would default to a DDR4 memory speed of 2,133MHz. Yet the X470 chipset officially supports DDR4 at 2,933MHz. We asked AMD why this was, and their reply made sense. While the officially supported speed is indeed 2,933MHz, AMD explained that, "Default speed is a little different... the default relates to the different DIMM types and the Serial Presence Detect (SPD), not to the platform itself, to enable a safe boot which you can then increase with XMP." So when you build your new X470 rig, ensure you head into the BIOS to change the memory speed manually up to 2,933MHz.

$269 | WWW.ASROCK.COM

ASRock Fatal1ty X470 Gaming K4

ASRock covers all of your peripheral requirements.

We're not sure when ASRock is going to stop using the 'Fatal1ty' brand given that most millennials probably have no idea who this pro-gamer once was, but in the meantime, they're sticking with it when it comes to products focused on gamers. At an almost identical price to the Aorus 'board (see over the page), ASRock has made a couple of slightly different decisions regarding features to help set it apart from the pack.

Here, we see the standard ATX form factor in use, but ASRock has populated it with an interesting choice of PCIe slots. Rather than go for three full-length PCIe x16 slots found on most other motherboards, they've instead limited it to two, and we think this is a wise decision. By doing so, it's allowed the engineers to free up space for a total of four PCIe x1 lanes. Most users will probably have a maximum of two devices that need full-length lanes, in the form of an SLI or CrossFire dual graphics card setup, whereas there are many more uses for PCIe x1 lanes, such as SSDs, add-on Wi-Fi cards or soundcards. Both of the full-length lanes are reinforced with steel, which is identical to the top two on the Aorus and ASUS.

You'll probably overlook the first M.2 slot, as it's hidden under a large heatsink that blends in with the rest of the 'board. This one supports the faster PCIe Gen 3.0 x4 speed, while the secondary M.2 slot only supports PCIe Gen2 x2. Like the Aorus board, the top M.2 port can handle the longer, less common 22110 form factor M.2 drives, while the lower slot, which doesn't have a heatsink, sticks to 2280 drives as a maximum.

Unlike the Aorus, however, ASRock is using the standard version of Realtek's ALC1220 audio codec, which is tucked away under a plastic shield. ASRock has implemented PCB isolation to lower the chance of EMF crackling, and claims the included DAC has a 120dB SNR, equivalent to high-end sound cards of the past. Like all modern 'boards, it also offers front connection for 600-ohm headphones.

Six SATA 3 connectors offer RAID 0, 1 and 10 support, but the range of outputs on the rear isn't quite as extensive as other motherboards. There are eight USB ports in total, comprised of a single USB 3.1 Gen2 Type-A, single USB 3.1 Gen2 Type-C and six USB 3.1 Gen 1 ports. Surprisingly, ASRock has also included ye olde PS/2 Mouse/keyboard connection, which we think is at least half a decade obsolete.

HDMI 2.0, SP/DIF and five 3.5 stereo minijacks deliver video and audio outputs.

We like ASRock's decision to go with its unique PCIe physical lane layout, as we think it will prove to be of more use to most users. However, it's not quite as feature packed when it comes to I/O options as other models, and the audio isn't as good as the Aorus. Still, if you want a motherboard that can handle plenty of add-in cards, this is probably the best choice for you.

Verdict

Features	★★★★☆
Performance	★★★★½
Value	★★★★½

ASRock has managed to differentiate itself from a crowd, arguably making it the most usable of the lot.

★★★★½

apc RECOMMENDS

$329 | WWW.ASUS.COM/AU

ASUS RoG Strix X470-F Gaming

One for the tweakers on a budget.

At $60 or so more than the other motherboards in our roundup, we were very interested to see what ASUS would offer in return for the higher pricetag. It turns out that not only is this 'board slightly faster when it comes to our benchmarks, but tweakers will find much to like if they want to get their hands dirty in the BIOS.

We have to point out the BIOS as it is easily the most detailed of the lot when it comes to tweakability. ASUS backs this up with the fastest rated memory overclock speed of 3,600MHz, along with an arguably superior CPU power supply comprised of a 10+1 digital power phase control. And yet, this is one of the few boards that doesn't feature the optional 4-pin CPU power plug to supplement the normal 8-pin plug, a feature that allows for more aggressive overclocking when present.

Once again, we see the standard ATX layout, but ASUS has managed to cram in three PCIe x1 physical lanes as well as three full-length PCIe x16 lanes, though you'll lose physical access to two of the PCIe x1 lanes if you populate the top two full-length lanes with dual-slot GPUs. There are twin M.2 slots, but they're faster than the competitors. The first operates at full speed PCIe 3.0 x4, while the second operates at PCIe 3.0 x2 – most other 'boards limit the second M.2 slot to PCIe 2.0 speeds. Six SATA 3 slots equal those of its competitors.

ASUS's superior version of the Realtek ALC1220 codec makes its return, in the form of the S1220A, which is a customised version of the chip made especially for ASUS. Despite this, the company claims it still has the same 120dB SNR playback of the regular ALC1220 codec, while it has a 113dB SNR for recording. There doesn't appear to be any PCB shielding, though there is a metal cover to inhibit EMF interference.

We love the super sexy I/O cover at the rear, a feature usually only found on more expensive motherboards. There are eight USB ports in total, with five USB 3.1 Gen 1, and three USB 3.1 Gen 2 (one of which is Type-C). There's also a DisplayPort output alongside the HDMI 2.0 port, which is unique to this 'board, along with the usual SP/DIF and five stereo minijacks. Like ASRock, ASUS has opted to include an ancient PS/2 mouse/keyboard connection.

One final mention we should include is the vast array of headers for fans and pumps, which is significantly more detailed than on other motherboards. Again, this points to the fact that ASUS intends this 'board to be aimed more at tweakers than the competition.

While the basic feature set is comparable to the more affordable models, the additional features intended for overclockers are what sets this 'board apart from the pack. If you're looking to extract the maximum speed out of your new Ryzen CPU without spending another $100, this is a good mid-way point between expensive enthusiast 'boards and more affordable entry-level platforms.

Verdict

Features	★★★★★
Performance	★★★★★
Value	★★★★

The slight price hike introduces better overclocking features without breaking the bank. For tweakers.

★★★★½

$279 | WWW.GIGABYTE.COM.AU

Gigabyte Aorus X470 Gaming Ultra

Gigabyte delivers more than you'd expect at this price.

We've long come to respect Gigabyte as a fantastic manufacturer of high-end 'boards, with the company's overclocking prowess proven time and again. But how do its more affordable models perform when they don't have $700 or so to stack the PCB with exotic power phases, interesting extras and more bling than a Vegas strip?

This is a standard ATX-sized motherboard, and comes with a surprising amount of inclusions given the price. There are three full-sized PCIe x16 slots, though obviously, they don't all run at PCIe 3.0 x16 speeds, with the numbers dropping as each slot is populated. The good news is that the X470 chipset allows for two PCIe x16 lanes to both run at PCIe 3.0 x8 speeds, allowing for Nvidia SLI support. Obviously, this also means AMD's rival CrossFire dual GPU technology is included. There are two more PCIe x1 physical lanes for smaller devices, both of which fall back on PCIe 2.0 speeds, and the good news is that neither is covered if you use a dual-slot GPU.

Tucked in between the three main PCIe x16 lanes are two M.2 slots, but if you fill all of your PCIe lanes, you'll find there's a juggling act as to how many of these you can use, and at what speed. The largest of these can fit a large type 22110 M.2 drive, and comes with an aluminium heatsink, while the second heatsink-free slot is limited to the more common 2280 sized M.2 drives. A total of six SATA 3 ports are included, which can be run in RAID 0, 1 or 10 modes. There's no sign of eSATA support or U.2 ports, though, which is to be expected at this price.

Realtek's ubiquitous ALC1220 codec has been used to deliver onboard audio, though Gigabyte has improved on this by using a version of it known as the ALC1220-VB, which improves front and rear microphone performance with an SNR of 110dB(A) for the front and 114dB(A) for the rear. It's also decked out with improved audio capacitors, though it doesn't appear to have PCB isolation, as found on other 'boards.

Heading to the I/O port at the rear of the board, there's a total of ten USB ports, broken down into four USB 3.1 Gen 1 ports, one USB 3.1 Gen 2 Type A, one USB 3.1 Gen 2 Type C and another four USB 2.0 ports. That's a rather impressive amount, especially given you can have another five ports if you utilise the onboard headers. There's also HDMI 2.0 out in case you're using a Ryzen APU chip, along with SP/DIF out and five 3.5mm stereo minijacks for old-school sound systems. Don't expect any onboard buttons for resetting the CMOS, power on or the like, as this board isn't really intended for serious overclockers.

Compared to 'boards that are $100 more expensive, the only major omissions are better overclocking and Wi-Fi support, both of which aren't must-haves. And as our benchmarks show, it performs just a little better than some others in this price range, though in real-world terms, the difference won't be noticeable.

Verdict

Features	★★★★
Performance	★★★★½
Value	★★★★½

Colour us ipressed. Gigabyte has delivered more than we expected at this price point.

★★★★½

$239 | AU.MSI.COM

MSI X470 Gaming Plus

How low do you want to go?

It's obvious from the moment you first open the box of the MSI X470 Gaming Plus that keeping costs down was a priority for the company. It's definitely not a looker, with rather sparse cosmetic additions and lots of visible PCB traces, but for those who don't have a Perspex window, does it really matter? At the end of the day, MSI has delivered an X470 motherboard that performs just as well as the rest, for a remarkably low price.

Despite such a rock-bottom price tag, most of the basic features you'll find elsewhere are all present and accounted for; it just doesn't look as pretty. The ATX layout has allowed MSI to fit three full-length PCIe x16 lanes, though only one of these has steel reinforcement, whereas all of the competitors always have the top two reinforced to stop GPU sag if you're running SLI or CrossFire. Squeezed between these are three more PCIe x1 lanes, but like most 'boards, you'll lose physical access to those nearest the full-length lanes if you fit a dual-slot card.

MSI makes much ado about its military-class certification when it comes to quality, so the lack of this feature on this budget motherboard was a little surprising; instead it carries the 'Gaming Certified 1' badge, suggesting that the quality of the components used isn't quite up to the usual long-term lifespan found on MSI's more expensive models.

It may not be designed for tweakers, yet MSI has included the optional 4-pin CPU power connector alongside the traditional 8-pin CPU, which should deliver even more stable power for AMD's multi-cored behemoths.

Twin M.2 slots are included, though neither comes with a heatshield. As with the other 'boards, only the top can fit the longest M.2 size of 22110. Six SATA 3 ports is par for the course on the X470 at this price point, while the four memory slots are rated to handle memory speeds up to 3,466MHz thanks to the 'DDR4 Boost' design, which uses an isolated memory circuit to limit interference.

One area where the price differential is noticeable is the onboard audio, which uses Realtek's ageing ALC892 codec. This is rated to have an SNR of 95dB, which is substantially lower than the 120dB of the newer ALC1220 codec used on other 'boards. As a result, we'd suggest popping in a cheap soundcard to make up the difference.

In terms of I/O options, there's also been some trimming in terms of USB outputs, with four USB 3.1 Gen 1, two USB 3.1 Gen 2 and two USB 2.0, and no sign of a Type-C connection. Along with the HDMI output, which is only HDMI 1.4, there's an archaic DVI-D output in case you have a monitor circa 2006.

While there have been a few areas cut to keep the cost down, performance hasn't suffered. Our biggest issue is the use of the ALC892 audio codec, which is noticeably inferior in practice to the ALC1220 codec found on other 'boards, and will require the use of a peripheral sound device if you're not outputting audio via HDMI to a receiver. And if you do have to buy an additional sound device, the price difference becomes null and void, making this motherboard hard to recommend.

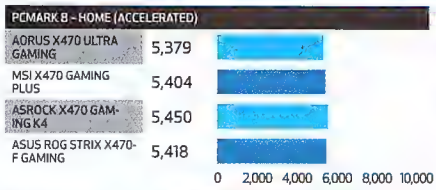
Verdict

Features ★★★☆☆
Performance ★★★★½
Value ★★★★☆

It might be the cheapest around, but a few too many features have been trimmed to hit this price point.

★★★½☆

LABS BENCHMARK RESULTS


PCMARK 8 - HOME (ACCELERATED)
AORUS X470 ULTRA GAMING 5,379
MSI X470 GAMING PLUS 5,404
ASROCK X470 GAMING K4 5,450
ASUS ROG STRIX X470-F GAMING 5,418
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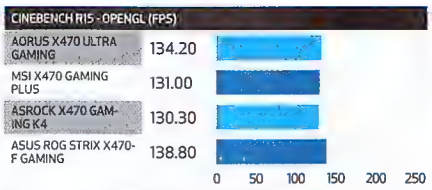
CINEBENCH R15 - OPENGL (FPS)
AORUS X470 ULTRA GAMING 134.20
MSI X470 GAMING PLUS 131.00
ASROCK X470 GAMING K4 130.30
ASUS ROG STRIX X470-F GAMING 138.80
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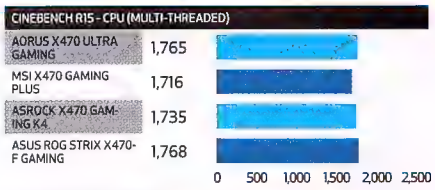
CINEBENCH R15 - CPU (MULTI-THREADED)
AORUS X470 ULTRA GAMING 1,765
MSI X470 GAMING PLUS 1,716
ASROCK X470 GAMING K4 1,735
ASUS ROG STRIX X470-F GAMING 1,768
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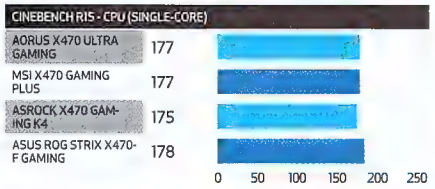
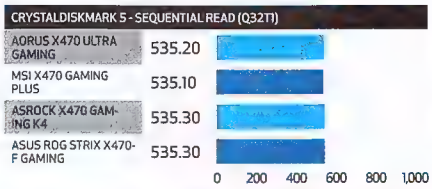
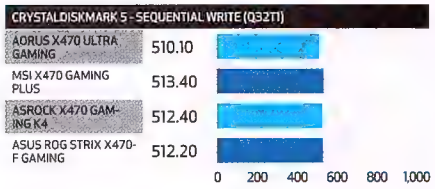
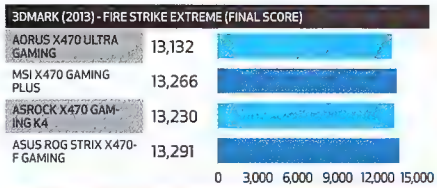
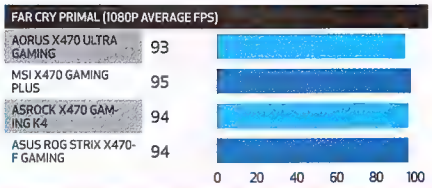

CINEBENCH R15 - CPU (SINGLE-CORE)
AORUS X470 ULTRA GAMING 177
MSI X470 GAMING PLUS 177
ASROCK X470 GAMING K4 175
ASUS ROG STRIX X470-F GAMING 178
0 50 100 150 200 250


CRYSTALDISKMARK 5 - SEQUENTIAL READ (Q32T1)
AORUS X470 ULTRA GAMING 535.20
MSI X470 GAMING PLUS 535.10
ASROCK X470 GAMING K4 535.30
ASUS ROG STRIX X470-F GAMING 535.30
0 200 400 600 800 1,000


CRYSTALDISKMARK 5 - SEQUENTIAL WRITE (Q32T1)
AORUS X470 ULTRA GAMING 510.10
MSI X470 GAMING PLUS 513.40
ASROCK X470 GAMING K4 512.40
ASUS ROG STRIX X470-F GAMING 512.20
0 200 400 600 800 1,000


3DMARK (2013) - FIRE STRIKE EXTREME (FINAL SCORE)
AORUS X470 ULTRA GAMING 13,132
MSI X470 GAMING PLUS 13,266
ASROCK X470 GAMING K4 13,230
ASUS ROG STRIX X470-F GAMING 13,291
0 3,000 6,000 9,000 12,000 15,000


FAR CRY PRIMAL (1080P AVERAGE FPS)
AORUS X470 ULTRA GAMING 93
MSI X470 GAMING PLUS 95
ASROCK X470 GAMING K4 94
ASUS ROG STRIX X470-F GAMING 94
0 20 40 60 80 100

* All motherboards tested with an AMD Ryzen 7 2700X CPU

SPECIFICATIONS

	GIGABYTE AORUS X470 ULTRA GAMING	ASROCK X470 GAMING K4	ASUS ROG STRIX X470-F GAMING	MSI X470 GAMING PLUS
SATA 6GBPS PORTS	6	6	6	6
M.2 PORTS	2	2	2	2
EXPANSION SLOTS	3 x PCIe x16; 2 x PCIe x1	2 x PCIe x16; 4 x PCIe x1	3 x PCIe x16; 3 x PCIe x1	3 x PCIe x16; 3 x PCIe x1
NETWORKING	1 x INTEL GBE LAN	1 x INTEL GBE LAN	1 x INTEL GBE LAN	1 x REALTEK GBE LAN

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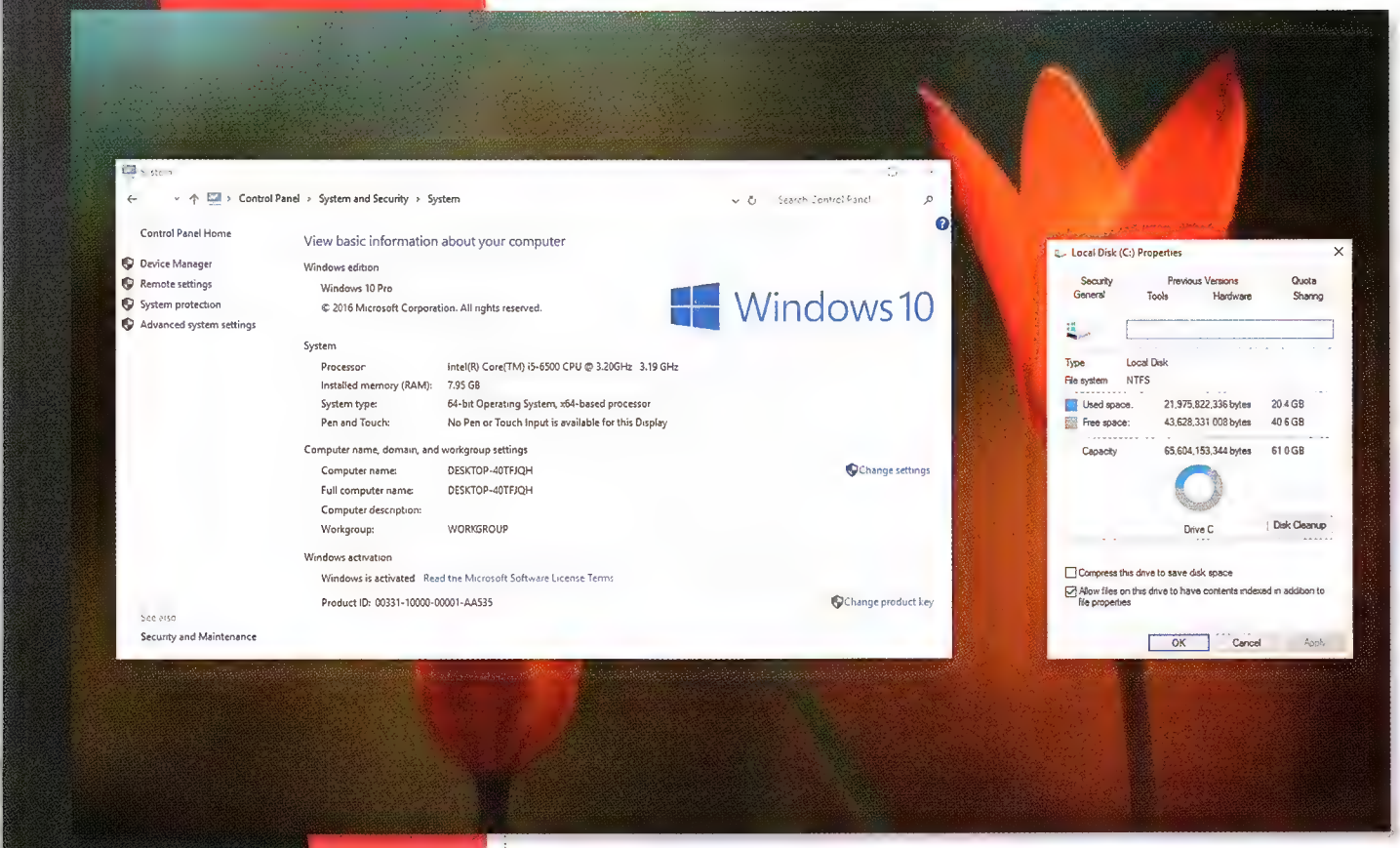
SUPERGUIDE: PART 1

DIY TECH SUPPORT

IF YOU'VE GOT A PROBLEM AND NOBODY ELSE CAN SOLVE IT, LOOK A LITTLE CLOSER TO HOME.

When it comes to tech, a little knowledge goes a long way. Windows 10, especially as it becomes more mature, is growing in stability, and it's a long way ahead of its predecessors, but – and it's a big 'but' – it is still beset by little niggles and gripes that can make it difficult to use. But you're the master of your own domain, and you can be the master of your own PC. Those problems can be banished by a little knowledge, either of the right thing to do or the right place to look. And while we here at *APC* endeavour to bring you the best fixes and tweaks on a regular basis – and our support team solves very specific issues – we can't be there for you every minute of the day.

What we can do, however, is bring you a collection of the most common Windows 10 problems and the best ways to solve them. We've broken them up into categories to help you find your way around. Look out for highlighted words – we've pulled these out to help you find fixes for particular components and elements. The next time you run into an issue, check this guide – chances are the solution will be here, but if you're still stumped, we'll lead you to the right places to find the answer.



1 THE PERFECT WINDOWS PC

If you're planning to move to Windows 10, installing the OS might be the first area where you run into problems. Installing a new operating system requires a certain amount of free space on your drive, so that it can be downloaded and certain elements can be run successfully.

For Windows 10, the minimum space requirement is 16GB, which should be kept free on the main system drive the computer uses.

This is actually the same as previous versions of Windows, so if you've upgraded before, you can most likely do it again. To check how much space you have left, go to My Computer (or This PC depending on the version of Windows you're running) where any drives you have will be listed. You can see the remaining space indicated underneath each drive, or you can right-click and select Properties for a clearer overview (the system drive is usually C:). Just as with space requirements, your PC will also have to be capable of running Windows 10. This means it must reach certain minimum **system requirements**. Thankfully, the requirements for running Windows 10 are relatively low: a processor of 1GHz or faster; 1GB (32-bit) or 2GB (64-bit) of RAM; 16GB of free drive space; a Microsoft DirectX 9 graphics device; a Microsoft account and internet access. To find out your PC's spec, go to Control Panel and select System & Security, then System.

2 ACTIVATION

Some users have reported issues with **activating** their copies of Windows 10, which could have been down to a number of different reasons. In some cases, the easiest way to get around the problem is to purchase a legitimate copy of Windows 10.

Unlike previous versions of Windows, this latest one is almost exclusively available online, which means that official Microsoft websites are the best bet for your purchase. The company was once giving the OS away for free, but that promotion has now ended.

"The transition from Windows 8.1 to 10 was far less jarring than the move from Windows 7 to 8 was."

Media maladies

PROBLEMS PLAYING? WE'RE HERE TO HELP

Annoyingly, Windows 10 ships without DVD-playing software as a standard option. However, Microsoft offers an app as a download from the Microsoft Store — called Windows DVD Player — but it costs $22.45. The best bet for those who want to **watch DVDs** is VLC Media Player, which is free to download and fully supports Windows 10. VLC Media Player also supports a host of other file formats — even the weird ones — making it a very useful tool to have around.

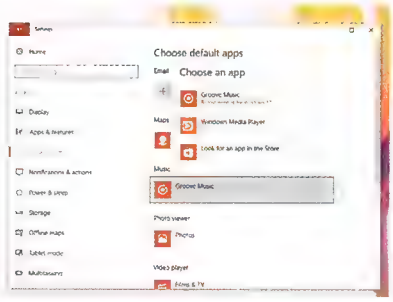
Of course, many of us have moved on from DVDs to the wild world of **media streaming**. Netflix and Amazon Prime both work on Windows 10's default browser, Edge, but may need an update to Silverlight, an application framework that Microsoft created and maintains.

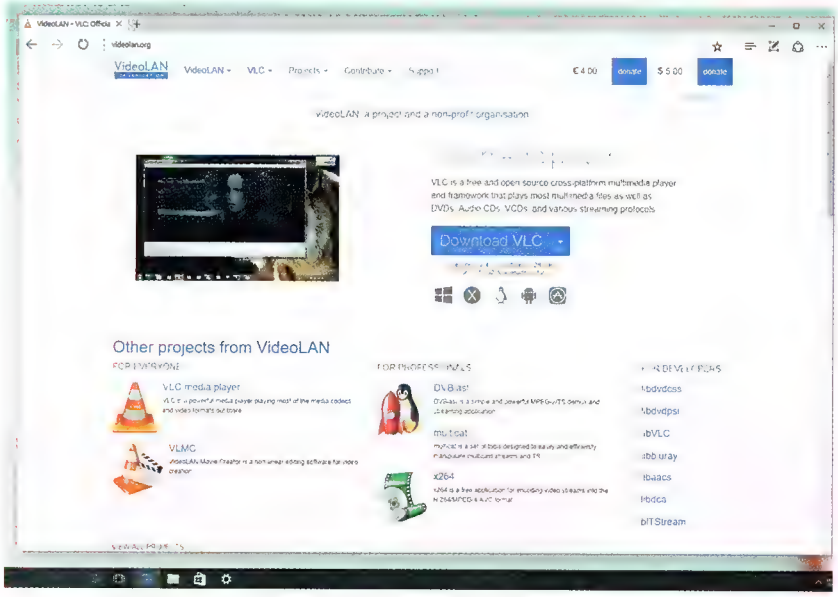
If you've upgraded from a Windows 7 PC, you could well suffer from this issue, as the older version of Silverlight may have travelled across when migrating. At any rate, if you're encountering streaming gremlins, to fix the problem and get back to binge-watching *Twin Peaks*, go to the Microsoft website where you can reinstall Silverlight — follow the instructions as detailed on the web page.

Then there's music. Although Microsoft still bundles Groove Music with Windows 10, the service has been deprecated, with Microsoft now recommending **music-streaming** service Spotify instead. However, there are plenty of alternatives out there, from Google Music to Deezer and Tidal, as well as Apple Music with a standalone version of Apple's iTunes for Windows 10 now available from the Microsoft Store.

Browser-based streaming services — such as Google Music — are also supported, of course. But bear in mind that they may not work well in Edge, because Windows 10's browser doesn't stream multimedia when minimised. At any rate, to set the default music service (ie, the one songs will automatically play with), head to 'Start > Settings > System' and select the Default Apps tab in the column on the left. You'll see a Music Player section, which will present options based on the players you have installed. Select the one you want and click OK.

If you don't want to sign up for a streaming service and just want to play your existing music collection, then try MusicBee (**getmusicbee.com**). It's easy to use, powerful and free.





Microsoft has a helpful website that provides a downloadable copy in either 32-bit or 64-bit versions. If you do find that you're unable to activate Windows 10 successfully, Microsoft has introduced an activation troubleshooter. To access it, head to Settings, then click 'Update & Security', go to Activation and select Troubleshoot (you won't see this option if Windows 10 has already been activated successfully).

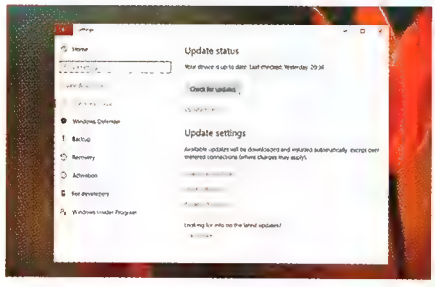
3 UPDATING

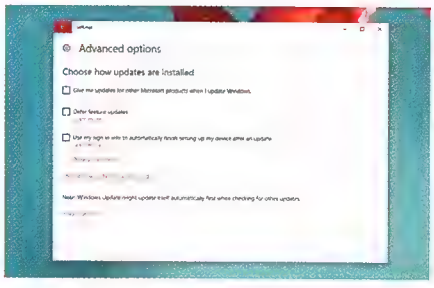
Windows 10 is, in many ways, a truly internet-based operating system. Mostly this is a bonus, but there are times when it isn't — and Microsoft's attitude towards downloading and installing **operating system updates** is one such time.

The most annoying part of automatic updates is the restarting, which can seemingly come at random (and inconvenient times). The simplest way to counteract this is to head to Windows Update (in 'Settings > Update & Security'), click on Advanced Options and then 'Notify to Schedule Restart', which means the OS will request a reboot rather than trampling all over the work you're not quite done with yet.

Each version of a new operating system also comes with its own set of backwards **compatibility issues** and Windows 10 is no exception. The transition from Windows 8.1 to 10 was far less jarring than the move from Windows 7 to 8 was, but there are still certain applications that can become broken and, in some cases, cease to work at all.

One such application is Chrome, which some users have had to fully delete and reinstall. If a program isn't working with Windows 10, try looking in the Microsoft Store or on the official website for the software





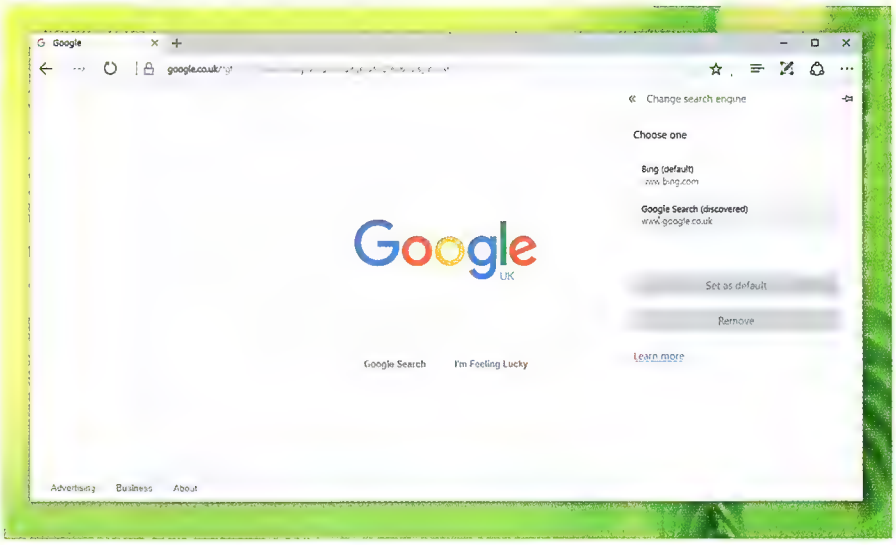
to find an update and, if that doesn't work, delete and reinstall it. Over time, more and more developers have updated their programs for Windows 10 compatibility; this is now less of a problem than it once was.

4 BROWSERS

The web browser is the heart of the modern PC. Microsoft ships Windows 10 with Edge, the successor to its Internet Explorer browser (although IE is still present in the OS). For many people, however, using Chrome or Firefox is the norm, no matter what Microsoft wants.

To **install Chrome or Firefox** – and get back to normality – open Edge, search for either, and find a Windows 10 version. Download it, install it and make sure it's set as the default browser option so that Edge doesn't keep reappearing. To do this, head to 'Settings › System', and click on Default Apps – click under Web Browser and select your preferred default browser.

If, however, you do want to use Edge, then you'll find it's actually a decent browser, but one that does come with some annoying features. Because it's a Universal Windows



> "If a program isn't working with Windows 10, try looking in the Microsoft Store or on the official website for the software to find an update and, if that doesn't work, delete and reinstall it."

Speed ups

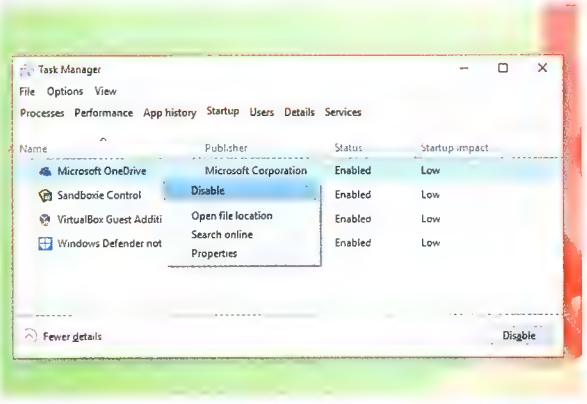
TAKE THE BRAKES OFF A SLUGGISH PC.

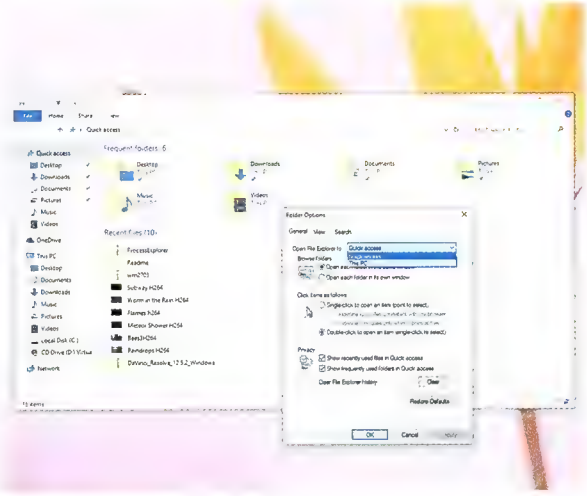
The easiest way to fix a PC **booting** sluggishly is by reducing the number of apps that launch on startup, as having too many programs firing up when the computer starts makes the whole process much slower, especially when it comes to older hardware.

To trim those apps, press 'Ctrl-Shift-Esc' to bring up Task Manager, then click the link that says 'More Details'. From here, select the Startup tab. Look through the list of enabled apps and find any that you don't need — you can turn an app off by right-clicking on it and selecting Disable. Disabled apps won't automatically load on boot up. Be careful not to turn Microsoft services off, mind you, or important apps such as antiviruses. If you're unsure whether it's wise to disable a certain app, Google it to find out.

Let's think beyond physical speed, now, and more towards **efficiency**. Do you feel like it takes you ages to get anything done in Windows 10? The Quick Access menu is located in File Explorer, and it can save a ton of time. To add files, folders or apps to the sidebar, right click on their icon and select 'Pin to Quick Access'. This means they will show up and can be easily accessed, which is useful for recently visited folders.

You can also set File Explorer to load the Quick Access menu by default when you bring it up, rather than This PC. To do so, with File Explorer open, click on the View tab in the top menu (next to Share), then click on Options, and select 'Change folder and search options'. Now look where it says 'Open File Explorer to', and use the drop-down menu to select Quick Access.





App, Edge runs on smartphones, tablets, PCs and almost any other device. This means that it sometimes has a problem with being too much like a phone app rather than a PC program.

One of the ways this manifests itself is by sometimes refusing to **play media when minimised**, just as a phone app wouldn't. There's a fix for this, but it's tucked away in a rather obscure location. Head to 'Settings > Privacy > Background apps' and enable Microsoft Edge (switch it to On) in the list on the right to enable the browser to keep itself going in the background. There's another issue with Edge, and it's often one of personal taste. Many people just don't like the Bing search engine, most likely because they have always used Google. That's fine, and we're sure Microsoft understands.

Changing Edge's search engine over to Google is relatively simple. Navigate in Edge to "google.com" (or Yahoo or whatever your preference) and click the ellipsis (...) in the top right corner. A drop-down menu will appear: select Settings, and then navigate down to click View Advanced Settings. From here, scroll down to 'Search in the address bar with...' and select Add New. Some users have reported that Add New often has no results in it, suggesting that no new search engine can be added. This isn't true. To get past this, close and then reopen Edge and (hopefully) some results will appear. One slight issue: you won't be able to ask Cortana to search with Google. It'll always use Bing, which can be something of an irritation.

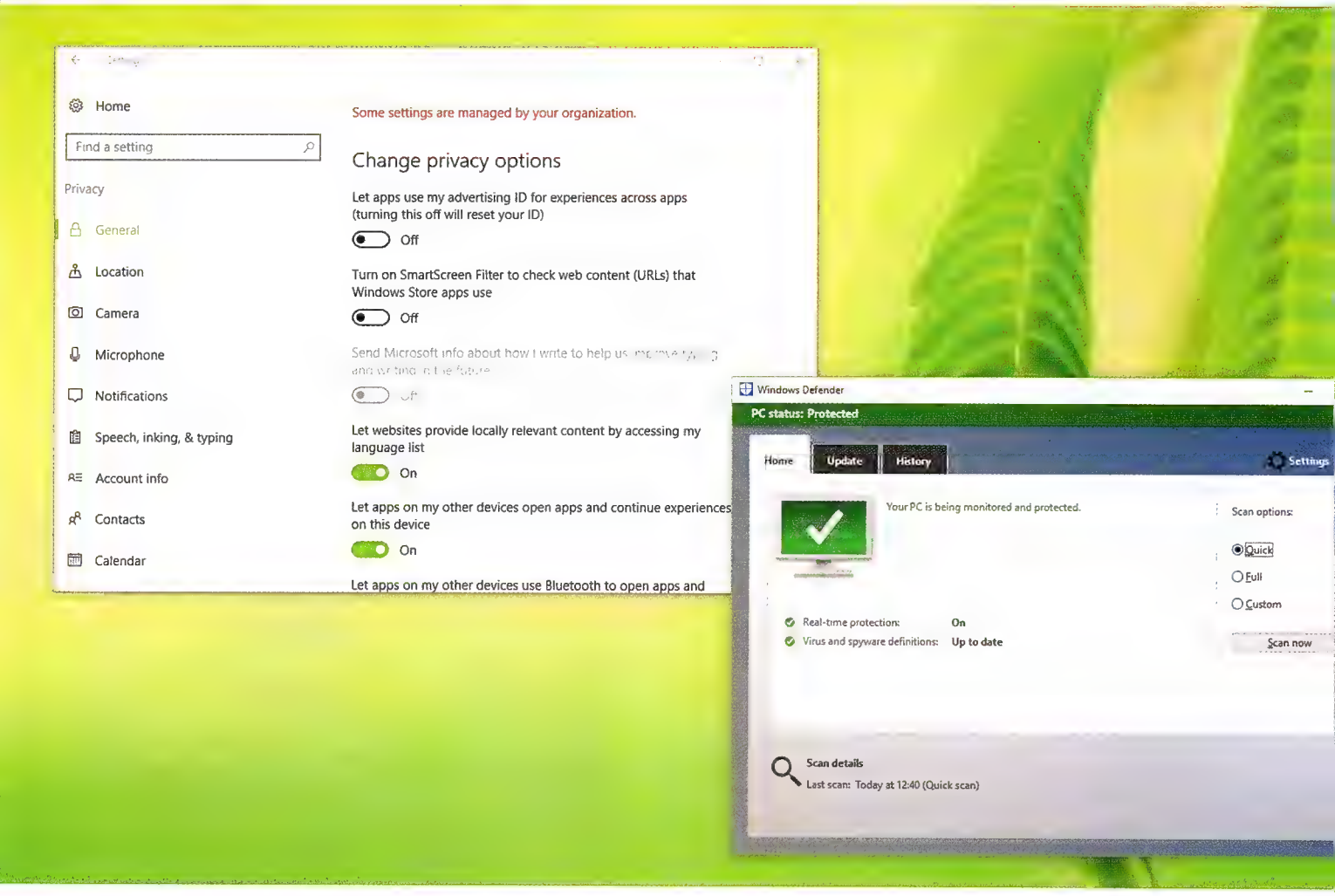
5 PRIVACY

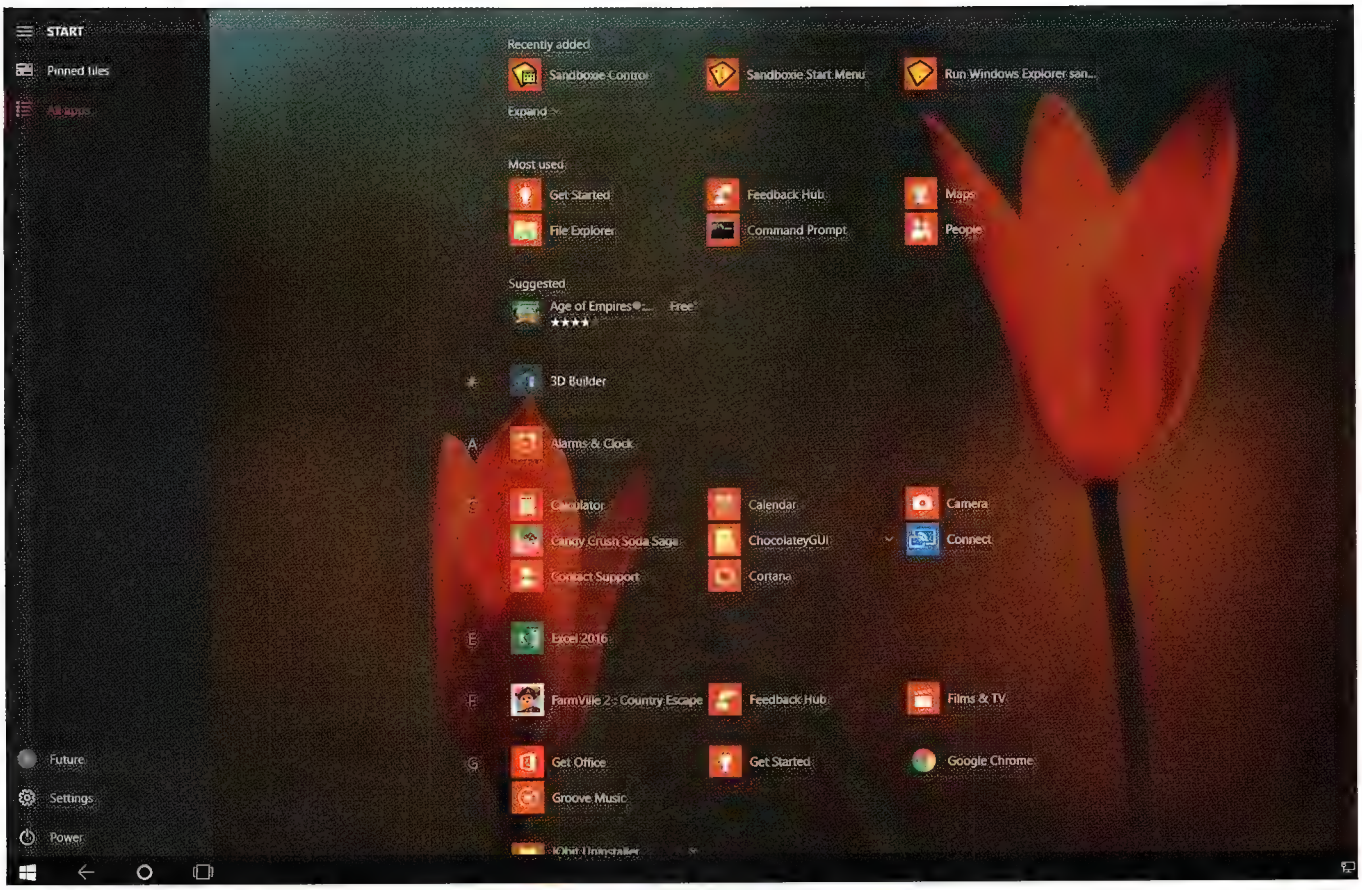
Data security is incredibly important, especially as hackers become increasingly sophisticated and the number of complex cyber-attacks is on the up. An unprotected PC is basically an invitation to be interfered with, and you might not even know you're being exploited – the days of openly malicious viruses are somewhat behind us.

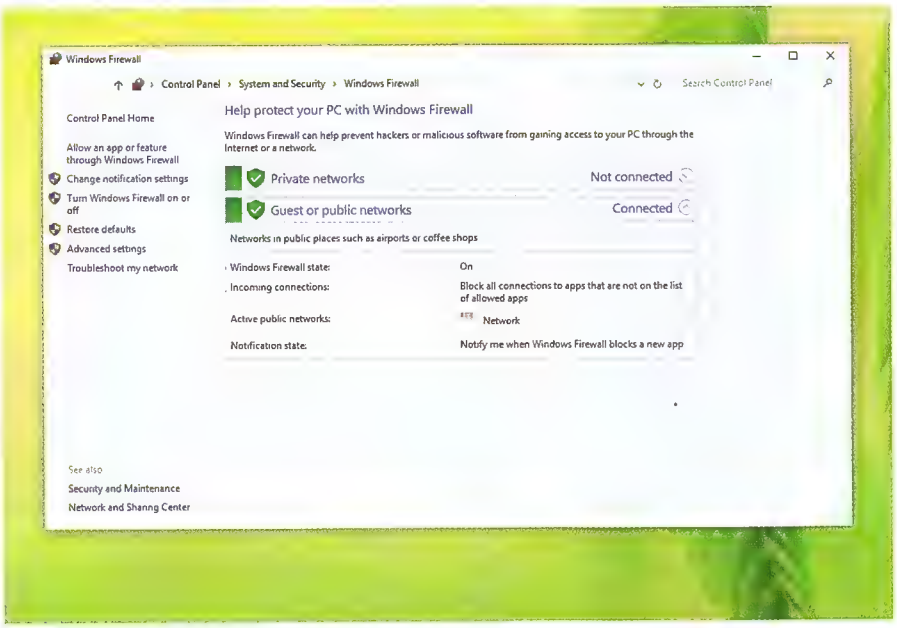
> "Security is important, as hackers become more sophisticated and cyber-attacks are on the up."

Windows 10 comes with a decent set of built-in protection measures, but you can never be too careful. One such feature that should be disabled by privacy-minded individuals is **Wi-Fi Sense**, which automatically shares the Wi-Fi password across Windows 10 devices on the same account.

Microsoft updated Wi-Fi Sense to share less data, but switching it off is the ideal way of preventing anything you don't want happening. To turn it off, go to the Start Menu, select Settings and click on Network & Internet, then Wi-Fi, and head to Manage Wi-Fi Settings – turn off all the options in here. Also in Settings, it's possible to get an overview of everything else happening on Windows 10 in terms of privacy – unsurprisingly, under the Privacy section. In here, you'll be presented with a bunch of toggles that adjust






Windows Firewall
Control Panel › System and Security › Windows Firewall
Search Control Panel
Control Panel Home
Allow an app or feature through Windows Firewall
Change notification settings
Turn Windows Firewall on or off
Restore defaults
Advanced settings
Troubleshoot my network
Help protect your PC with Windows Firewall
Windows Firewall can help prevent hackers or malicious software from gaining access to your PC through the Internet or a network.
Private networks
Not connected
Guest or public networks
Connected
Networks in public places such as airports or coffee shops
Windows Firewall state:
On
Incoming connections:
Block all connections to apps that are not on the list of allowed apps
Active public networks:
Network
Notification state:
Notify me when Windows Firewall blocks a new app
See also
Security and Maintenance
Network and Sharing Center

some **privacy options** to help keep everything under control.

Windows 10 also ships with a variety of security features that it's a good idea to take a look at. One such feature to be aware of is **Windows Defender**, which is designed to detect and remove malware from PCs – you'll find it under 'Settings › Update & Security'. Make sure you have this turned on if you don't have another third-party **antivirus** solution running on your machine.

But, equally, make sure you don't rely on Defender; it's one of the least-effective antivirus tools there is, and you should definitely apply some third-party protection even if it's something free, such as Avira (**www.avira.com**).

Windows Firewall is the other half of Microsoft's basic efforts to keep your PC safe from malware and other attacks. It's easy to turn on, but configuring the firewall is a slightly more involved matter.

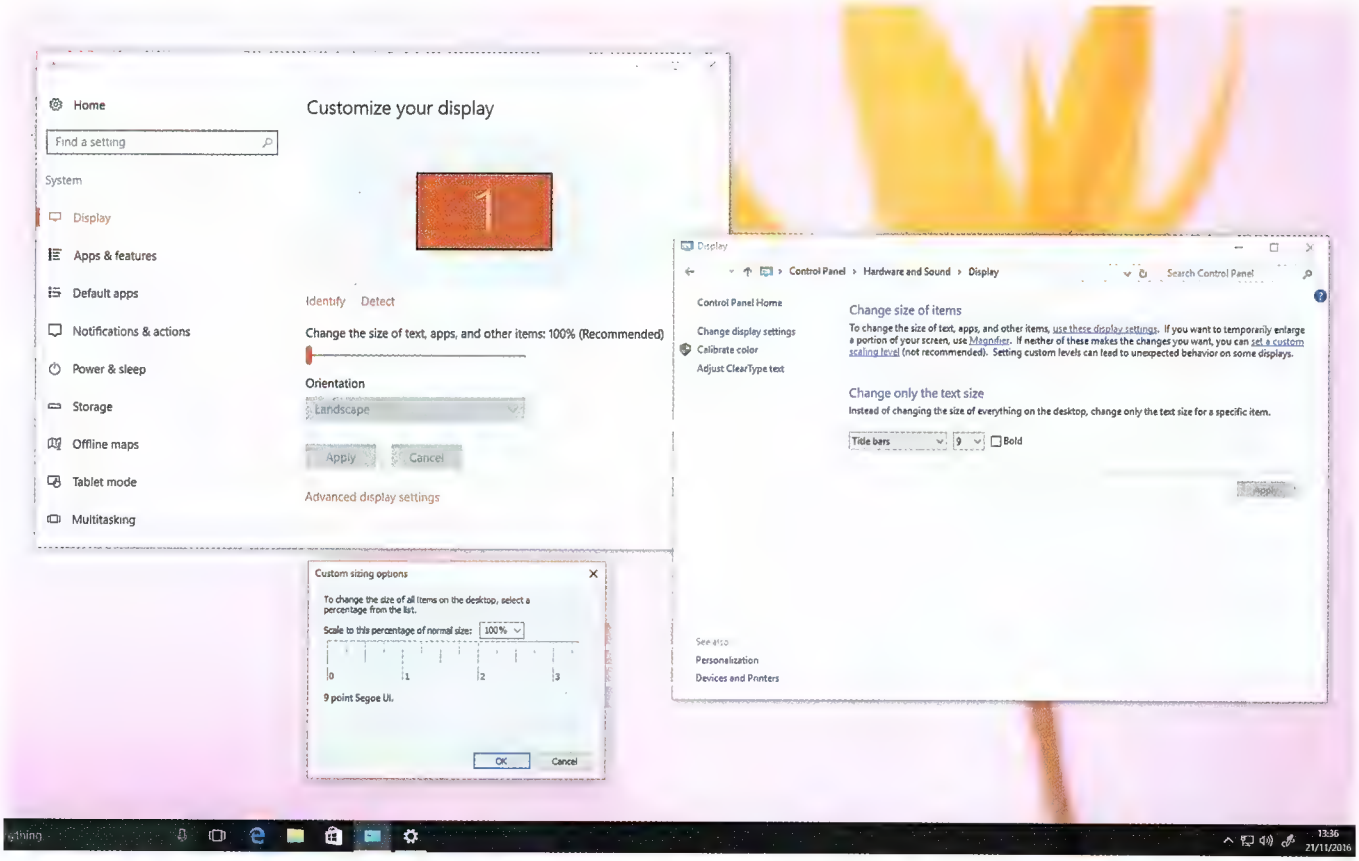
To switch on the firewall, or rather to make sure it's switched on as it should be by default, simply type "firewall" into the search/Cortana box (next to the Start menu), and click on Windows Firewall. From here, there's an option to turn it on (or off), and you can also adjust the relative 'strength' of the firewall.

Windows Firewall can be configured as incredibly strong via the Advanced Settings option – blocking all suspect apps without asking – or slightly weaker, which means there's a slightly greater risk that your PC will become hit with some kind of infection, but the firewall won't interfere as much.

6 INPUT ISSUES

If you've bought a Windows 10 machine that has a **touchscreen**, then you are, by and large, getting the best experience with the OS. Ever since Windows 8, Microsoft has been optimising its operating system for the finger – and sometimes pen – with large tiles, easy-to-scroll menus and so on. However, it can still be a little disjointed, but the easiest way to remedy this is simple: head to 'Start › Settings › System › Tablet Mode'. Then turn 'Tablet Mode on' – this optimises Windows 10 for fingers rather than pointers, making it far easier to use.

Having a **touchpad**-enabled laptop is also good for Windows 10, but some



users have reported that the upgrade from Windows 7 (and sometimes Windows 8) breaks it.

One of the ways to solve this is by first checking to see if your keyboard has a key that turns the touchpad off. You'll usually have to use the Function key (Fn) on your laptop with one of the F-keys; look for a symbol that looks like a rectangle with a cross through it.

If your laptop doesn't have such a function – or the right setting is toggled and you're still having issues – then head to 'Devices › Mouse & Touchpad › Additional mouse options'. A new window will appear. From here, select the tab that says Device Settings, then Devices and then make sure the touchpad is enabled. If none of these options work, press 'Win-X', select Device Manager, then the option for 'Mice and other pointing devices', and update the driver. This should fix things.

7 HARDWARE

We can't all keep up with the latest changes in tech. And neither should we have to. But this can, naturally, cause issues. Let's start with **printer compatibility**. If you're jumping from Windows 7 (or earlier) to Windows 10, then it's definitely worth updating all available printer drivers, which should help prevent them not working post-upgrade. Doing this is simple. Just search

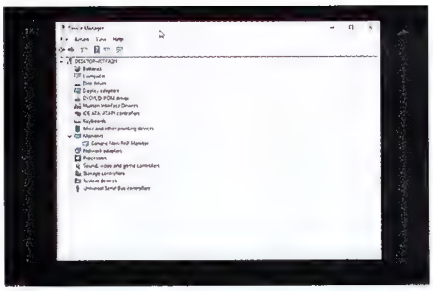
Startup Settings
Restart to change Windows options such as:
Enable low-resolution video mode
Enable debugging mode
Enable boot logging
Enable Safe Mode
Disable driver signature enforcement
Disable early-launch anti-malware protection
Disable automatic restart on system failure

"If you're jumping from Windows 7 to Windows 10, then update all available printer drivers."

Google (or Bing, depending on your preference) for the name of your printer and download the latest Windows 10 compatible drivers. Follow the manufacturer's instructions to install them and you're good to go.

Now on to screens. Users have reported issues with **high resolution displays** and Windows 10, including experiencing blurriness in applications that had been rendering fine on previous versions of the OS, such as Windows 8.1.

The easiest way to solve the issue of blurriness is by going to 'Control Panel › Display' and fiddling around with the settings here. There is no one single setting that will fix all issues, so experiment and see what works



(and what doesn't). To fix **blurriness** in specific applications, right-click on the app's icon and select Properties. Under the Compatibility tab there is an option to 'Disable display scaling on high DPI settings'. Tick this and – hopefully – the problems will disappear.

You may also find that your screen is **flickering** – this isn't always a hardware issue, as some users have found it to occur when upgrading to Windows 10. The easiest way to fix this is to update all relevant drivers for monitors, as well as Norton Antivirus, iCloud and IDT Audio, which are all suspected to be potential causes of these problems. It may even help to uninstall and then reinstall them.

Windows 10 does automatically update drivers, so there is also a chance it's forcing an incompatible version of a driver onto the PC without realising.

If you found that an upgrade to Windows 10 broke the connection of a **Bluetooth** device (or devices) that was previously paired up just fine with your machine, then there is an easy enough fix for this. According to Microsoft, all you have to do is head to Device Manager (just type "device manager" into the search/Cortana box next to the Start menu), select the Bluetooth driver and update it to the latest version, which will be compatible with Windows 10. The operating system should be able to automatically search, and then update, the driver. If that fails to work, unpairing (or 'forgetting') the device before re-pairing it should fix the issue.

8 MOBILE COMPUTING

Battery life is important to anyone who regularly uses a laptop, tablet or smartphone, and, of course, Windows 10 can be used on all three of those devices. Microsoft recognises this – as shown by the marketing of its Edge browser as being battery-friendly – and has built several tools into Windows 10 to help cut down on excessive battery drain. All apps that run in the background can be toggled off, for example, which stops them from sucking up precious juice.

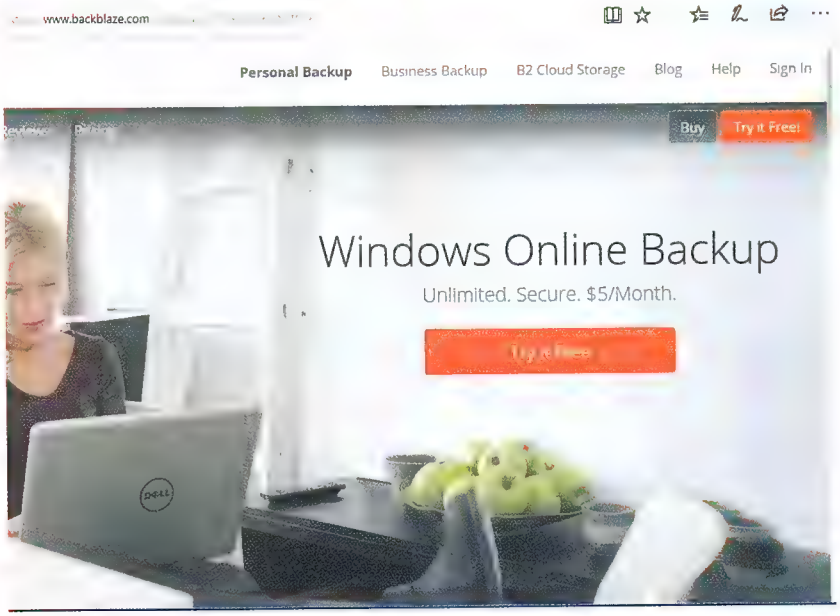
File safety

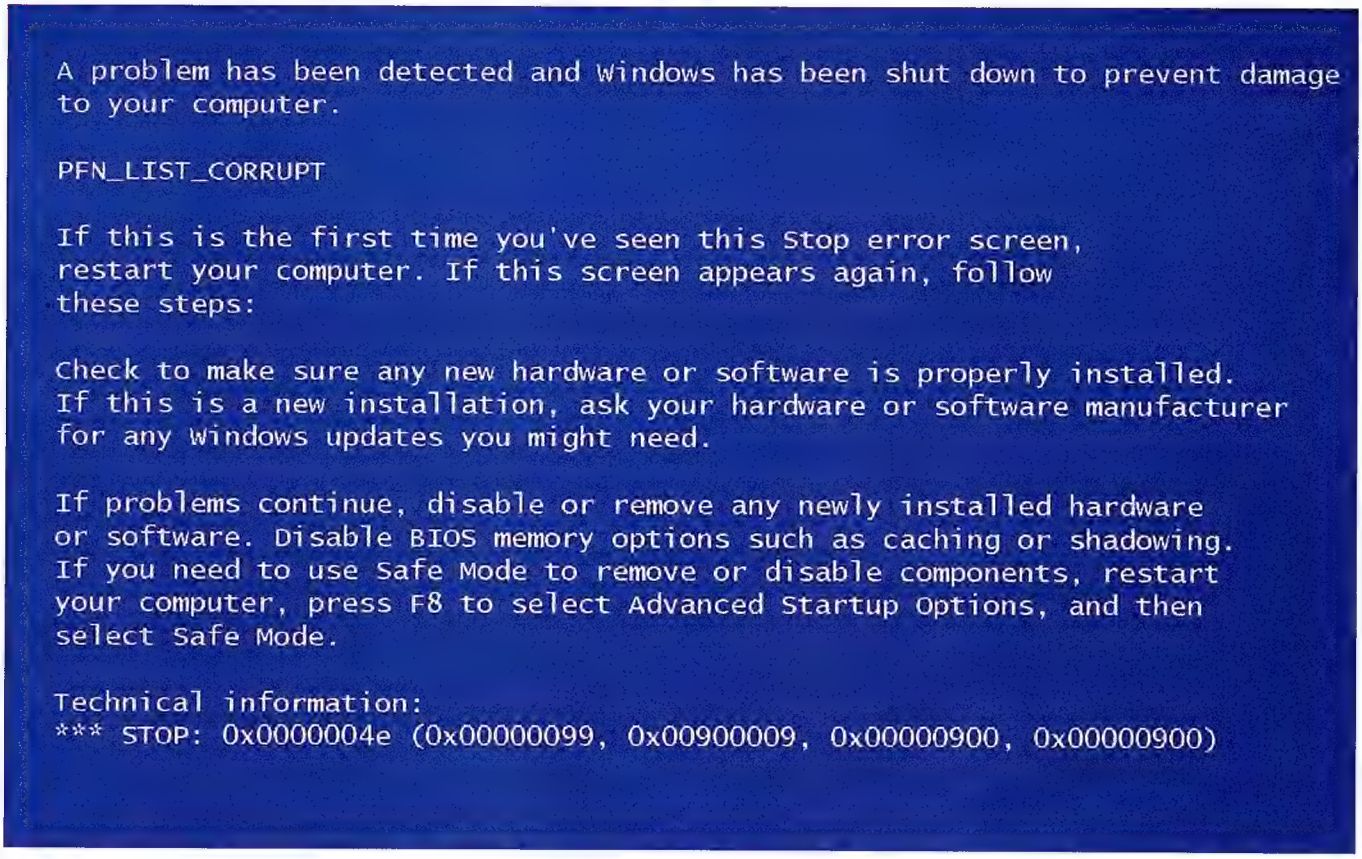
KEEP YOUR PHOTOS, VIDEOS AND DOCUMENTS SECURE.

Losing files after a disaster hits because you didn't back them up is a hugely frustrating experience, but fortunately, it's one that can be avoided easily. To **create a backup**, purchase an external storage drive (which obviously has to be larger in size than the data you want to store on it). You can simply copy your files across to this disk manually, of course, or you can set up **File History** in Windows. To do the latter, ensure the drive is connected to your PC, and left-click the Start menu, then click Settings. From there, click Update & Security and navigate to Backup on the left. See the 'Add a Drive' button next to the big '+' sign? Click this. Windows will scan for available drives on which to back up, and you should select the drive you want to use from the list it brings up. The OS will now get to work and you'll soon be done; an On toggle button will appear to show that the feature is active and automatically backing up your files (and will continue to do so as long as the drive is connected).

If a physical drive doesn't suit you (maybe you're worried about a fire, for instance, or the possibility of the backup disk corrupting), then there are plenty of **online backup** options you can use as an alternative. Backblaze (**www.backblaze.com**) has received some very good reviews and comes with various tiers suitable for single PCs right through to businesses. Alternatively, you could simply use a cloud storage locker like Dropbox or, of course, Microsoft's OneDrive, which is tied in directly with Windows 10.

Whichever online option you choose, do be warned that sending all your files over an internet connection could be a slow process — although that obviously depends on the quantity of files you have, and the speed of your broadband. Also be careful if you have data allowances on your broadband plan. It can be a good idea to have both a local backup on an external storage drive, and a further online backup — even if the latter only holds critical files and not everything.




A problem has been detected and Windows has been shut down to prevent damage to your computer.
PFN_LIST_CORRUPT
If this is the first time you've seen this Stop error screen, restart your computer. If this screen appears again, follow these steps:
Check to make sure any new hardware or software is properly installed. If this is a new installation, ask your hardware or software manufacturer for any Windows updates you might need.
If problems continue, disable or remove any newly installed hardware or software. Disable BIOS memory options such as caching or shadowing. If you need to use Safe Mode to remove or disable components, restart your computer, press F8 to select Advanced Startup Options, and then select Safe Mode.
Technical information:
*** STOP: 0x0000004e (0x00000099, 0x00900009, 0x00000900, 0x00000900)

Windows 10 also includes a dedicated set of power options, which you can find via 'Settings › System › Power & Sleep'. From here, display sleep times can be set and under Additional Power Settings you can select a power plan that means a lighter load for your battery.

If just fiddling with the settings isn't enough, Windows 10 can also generate a battery report. To do this, head to the Command Prompt Admin (which you get from right-clicking the Start menu), and type: `powercfg /batteryreport /output "C:\battery_report.html"` . This will save a file to any chosen folder – C:\ in this case, the root of your system drive – which gives you a hugely detailed look at battery quality, cycles, how much charge is left, and much more. The report is a little dense, so be warned.

Location-based apps are fairly prominent in Windows 10, which makes it a good idea to let your PC know where you are. Cortana, for example, can give far more information if it can pinpoint where in the world it's being used.

To update your computer's location settings, head to the Start menu, click Settings, Time & Language, then Region & Language – then make sure the correct country is selected. To turn on Location services, go to ;Settings › Privacy › Location;, and flick the Location switch to On.

"While Windows 10 is more stable, it's still prone to the odd bout of madness, so it pays to be prepared."

If you're on a tablet that has 4G, or if you're using a mobile hotspot or surfing the web via a 4G-enabled laptop, then the operating system may have a nasty surprise for you. Users have been reporting that the default configuration of Windows 10 sucks up data like there's no tomorrow, potentially putting you over your data allowance, and leaving you with a hefty bill. Fortunately, there's an option that addresses the problem. Simply to go 'Settings › Network & Internet › Wi-Fi'. Click Advanced Options and then 'Set as metered connection'. This means that Windows 10 will stop collecting so much data in the background.

9 MAJOR CRASHES

While Windows 10 is far more stable than many operating systems that came before it, it's also still prone to the odd bout of madness, so it pays to be prepared. A black screen on Windows 10 can mean several things, depending on whether you've logged into the operating system or not. If you haven't logged in, or Windows 10 hasn't booted, then your immediate diagnostic path should be to check your internet connection and then boot your PC in a different way. If you logged in and then the screen went black, unplug all external devices and, failing that, boot via Safe Mode. It's just what you'd expect – a safe way of booting up a PC and running the system with no startup apps and only essential drivers, which should hopefully enable the computer to boot successfully (when it won't otherwise due to some issue or other). With Windows 10, to access Safe Mode, hold down Shift during boot-up (or select Restart from the desktop while holding down Shift), then follow the menus on screen.

The Blue Screen of Death, also known as a BSOD or a 'stop' error, may sound bad but it's certainly fixable in the majority of cases. When the problem manifests, it halts your PC completely, stopping it working and showing a blue screen, usually with some kind of message about restarting or a critical error.

You'll then need to reboot. To fix this, you can explore several options. First, be sure to check how much available space you have left on your system drive and, if it's low, make some room by deleting bigger files or programs you don't need. Also, ensure all the latest updates are applied to the software on your machine, as having outdated apps can cause issues. While you're at it, you can update the hardware drivers of any peripherals, as the problem could be caused by Windows 10 clashing with something.

Head to Device Manager, which you can reach by searching for it in the Start menu. Here, you can ensure that the likes of peripherals, such as your monitor, webcam, printer or scanner – the extra devices you plug into your machine – have the latest drivers, simply by right-clicking on the device in question. Selecting Update Driver Software, then click 'Search automatically for updated driver software'.

10 GLITCHES

It's not uncommon for software, particularly older apps, to encounter glitches or even fail to run completely with Windows 10. There's one potential way to get around show-stopping bugs, though: right-click on the icon for the app and select Properties, then click on the Compatibility tab. From here, click the checkbox next to 'Run this program in **compatibility mode** for', and in the drop-down menu underneath that, choose the version of Windows that the program ran fine on. Over time, many developers will update their apps to remove bugs, so the software in question may eventually work just fine with Windows 10. An easy way to help them is by reporting any bugs you find, which can usually be done via the developer's website.

> "Older apps can often encounter glitches or even fail to run completely with Windows 10."

Alternatively, your PC may be in the grips of **slowdown** – perhaps the hard disk is whirring like crazy? If so, there's a good chance that one of the programs you're running may have developed some kind of issue and is sapping all your system resources. There's an easy way to find out if an app has gone haywire and is bogging down your computer. You need to head over to Task Manager (press 'Ctrl-Shift-Esc' together), and click on More Details – you'll then see a list of processes, which is all the different apps and services currently running on your machine. Scan down the list and look for any apps which are **hogging CPU**, memory or disk usage – or perhaps all of the above.

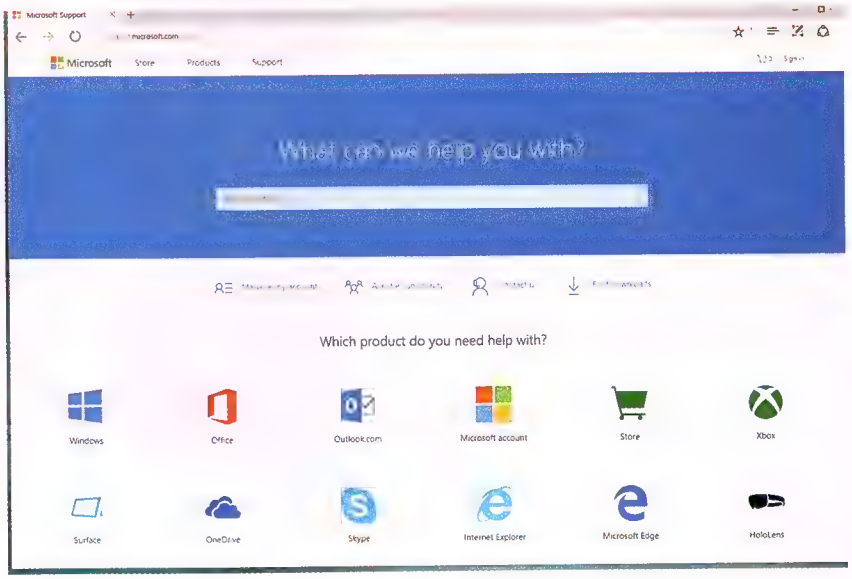
Once you've discovered the culprit, select it. There's an option in the bottom right corner to End Task. However, be careful that you aren't ending important system-critical tasks – usually ones with confusing names that won't mean anything to you – since this could cause your computer to crash.

If in doubt, Google or Bing is your friend here – open your web browser and search for the app/service you need information on and you'll almost certainly find an answer about exactly what it does. ■

What next?

STILL SEARCHING? DON'T WORRY...

If you haven't found an answer to your problem here, that doesn't mean it's completely insurmountable. You can always ask our friendly support team — just email your problems to **apcmag@futurenet.com** — for help. Of course, a subscription to *APC* is highly recommended, since we'll give you guides to fixes and tweaks every issue, such as this feature or our regular Windows Help Station section (on page 73). See page 61 for more details on how to subscribe. Once you've done that, check these sources to find out more about your problem.



ANSWERS.MICROSOFT.COM

Microsoft's forums may not always have the answer you're looking for — sometimes the response to your problem may be 'there's nothing we can do' — but since it's staffed by actual experts and a huge number of other users, it's a great place to look.

SUPPORT.MICROSOFT.COM

Microsoft's fully categorised breakdown of common issues with its software and products isn't so much an admission of defeat, as it is a consistently updated and reliable extra manual for your software — and it's one you should turn to whenever possible.

INTERNET SEARCH

If you've hit a specific error, this is the first place to turn. Try typing in your symptoms or the error code provided when your computer crashes; the results will likely point you to forums or blogs where people have come up with solutions.

SUPERGUIDE: PART 2

OPTIMISE YOUR UPGRADES

IDENTIFY BOTTLENECKS AND BREAK THROUGH INTO PRO-GRADE BENCHMARKING WITH ZAK STOREY.

Computers are funny things: a complicated collection of components, each working in conjunction with the rest to produce on-demand output. But as with any team effort, there is always a weak link in the chain.

As more and more people join the PC enthusiast community, it's easy to get swept up in the hype, and upgrade a very basic system with high-end componentry. And while that's not always a bad thing, it can lead to those weak links being stretched to breaking point, as top-end hardware makes its way into a system that wasn't designed to host it.

This can lead to bottlenecking, when one piece of hardware doesn't perform as well as it should, due to another component in the system being ill-equipped to handle the potential performance levels. As with the neck of a bottle, only so much can come through at once, so the power that's ready to be tapped is unused. It's usually easy to spot the part that is underperforming – a GPU, CPU or RAID setup – but identifying which component is causing the bottleneck can be more difficult.

So which are the most common problem parts? How do you identify them? And how do you break through that barrier? Read on to find out...

CORSAIR
msi
SAMSUNG
crucial
2.5-inch SOLID STATE DRIVE
RADEON
AMD

Integral system parts

The most common cause of bottlenecking is your platform and processor.

CPU

Bottlenecking is typically down to your processor. Your CPU processes everything from rendered in-game frames to memory storage requests, complex program processes and more. It's an intricate part of the puzzle, and the easiest to become overwhelmed in any system. Most common bottlenecks, especially in games, are due to the processor not being fast enough to handle all the data and processes thrown at it at any given time.

Six or seven years ago, most games required two to four high-powered cores to get the job done. Single-core was king, and the more instructions per clock your CPU could process, the better. Intel's well-founded single-core legacy comes from its early Nehalem architecture, which has seen no fewer than seven iterations since then, each capitalising on improved single-core performance and support for newer hardware. Today, Intel still holds that reputation, and despite the fact that Ryzen is now much closer to Intel's single-core performance, the gaming community still leans toward Intel rather than its Team Red rival.

CPU SYMPTOMS

The most common and obvious sign of a CPU bottleneck is low frame rates in games, even when using a powerful GPU. In short, your CPU is in control of the entire game. In a simplified view, it runs the process logic, handles your input to the game, runs the physics for that event, then calculates the AI's response, mixes the relevant audio given the triggers activated previously, and finally makes a request to the GPU to render the frame. At which point, it returns straight back to the process logic and starts all over again. It does all this while running the OS and any background apps, and moving data in and out of various frame buffers, DRAM, cache, and off the storage medium, back and forth between the GPU. To achieve a smooth 60fps, your processor has to manage all of that 60 times per second. In more complex titles, there are even more steps added to the game logic process chain, and as multiple events occur at the same time, it's easy to see how a low-end CPU struggles to handle a modern title.

GAME CODING

How the processor performs in-game, however, is dictated by the game devs. A CPU always operates at the same speed and frequency, processing the same number of instructions per clock every single second. If you send it a complex process to compute, filled with unnecessary jargon and redundant code, it takes up more of your processor's resources, so it takes longer to go through that chain, which in turn slows down frame rates. The developers can also allocate which processes take advantage of which cores, and how many of those cores.

SOLVING THE CONUNDRUM

Typical symptoms include long in-game load times, slow texture loading and lower frame rates than you'd expect, given the GPU you're using. On the flip side, you may notice seemingly high frame rates, but textures don't appear to render correctly, with horrendous levels of stutter and lockups.

To confirm this diagnosis, we need to do some testing and data collection. This requires an in-depth benchmark, such as the one integrated into *Assassin's Creed Origins* or *Tom Clancy's Ghost Recon: Wildlands*, and a third-party system monitoring app, such as HWInfo or HWMonitor. *Assassin's Creed* features a benchmark HUD, which actively shows you how many cores are being utilised, and what percentage of load they're under, while also displaying you the maximum GPU load. Regardless of what you use, we're looking for the same info: CPU and GPU load.

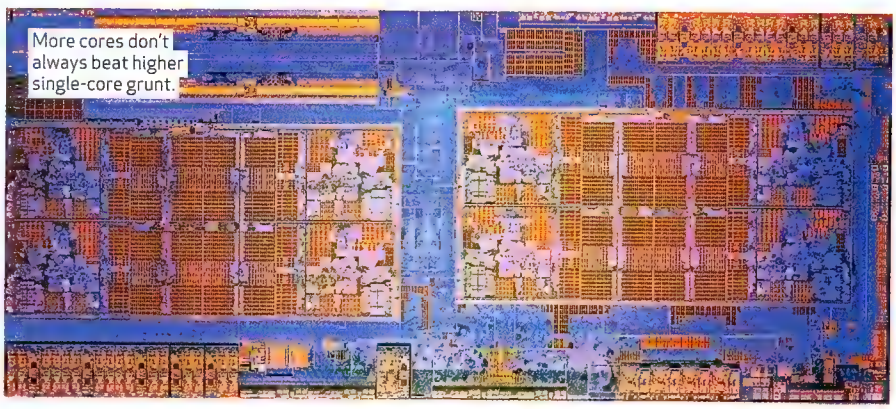
If, for instance, you have a processor with two cores and multithreading – an old Intel Core i3, say – and all four of those logical cores are registering 100% load for the duration of the benchmark, with the GPU hovering around 60–80%, we can safely say the CPU is the bottleneck, because in an ideal world, the reverse would be true. This is what we call an absolute bottleneck, as you'll start to see in-game degradation, textures not loading, slow load times, and frame stuttering. That said, you don't necessarily need all of your CPU cores running at 100% load to find yourself with a bottleneck; minor ones can occur due to slower single-core performance.

The differences are most notable at higher refresh rates, with higher powered GPUs, but they still exist at the low end. And if you play competitive FPS games at 144Hz and above, at 1080p, single-core performance is still very much king in contrast to multicore brute force.

CAN YOU STILL BOTTLENECK?

Despite what most folk think, we've come a hell of a long way over the last seven years. And although Intel's 10% incremental performance increases generation upon generation haven't exactly wooed anyone, almost a decade of them has led to single-core performance increasing by a staggering 93% since Sandy Bridge. Combine that with access to more cores as the market heats up, thanks to the battle between teams Red and Blue, and what you're left with is quad-core $170 i3s pumping out nearly twice as much grunt as their siblings back in 2010.

Game development has stagnated in comparison. Although graphics in the big triple-A titles have improved in leaps and bounds, few developers take advantage of more than four cores. This is purely down to the fact that the majority of the market still sits on quad-core parts. What that means is that in today's world, even that $170 Core i3-8100 will be more than enough to play the vast majority of modern games without bottlenecking any GPU, certainly at 4K.



More cores don't always beat higher single-core grunt.

Thanks for the memory

How much is enough? What about frequency?

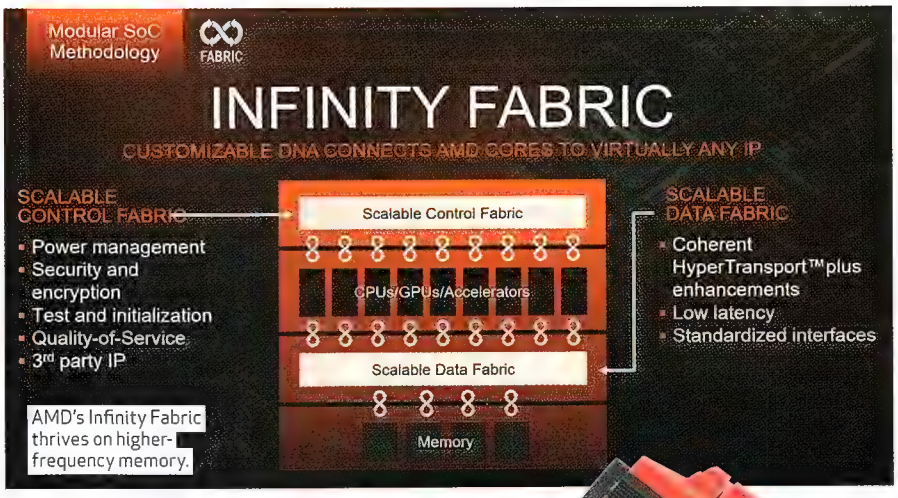
Memory is an integral part of any system, and it interacts with the CPU in a very interesting way. It's essentially a hyper-fast, volatile storage medium, designed to hold data that needs to be accessed more quickly than that found on non-volatile hard drives, yet using files that are larger than those that can be held locally on the internal CPU cache.

When it comes to processors, outside of rendering tasks or simulations that operate off large data sets, it's difficult for your memory to bottleneck your system. Most everyday tasks don't process or shift enough data fast enough for the bus between the DDR and the CPU to ever become truly saturated, or for the memory to be under 100% load all the time.

You can encounter bottlenecks when video rendering, as large amounts of data and imported video clips are transferred from the non-volatile storage to the DDR, then the CPU and GPU, but aside from that, memory speed (frequency, in this case), for Intel at least, matters very little.

INFINITY FABRIC

AMD's Ryzen architecture, on the other hand, does take advantage of increased memory speeds for flat single and multicore performance increases, because the interweaving fabric that connects each of Ryzen's core complexes together runs at the same frequency as the memory itself. This means that the higher the memory speed, the faster the Infinity Fabric runs, and therefore the faster each core complex can transfer data and instructions between the other complexes and cores in turn. That said, there are diminishing returns from increasing memory frequency with Ryzen parts — typically, anything above 3,200MT/s on the Ryzen 1000 series will fail to see any further improvement, while the Ryzen 2000 series increases that limit to 3,600MT/s.



Memory is the support class of PCs.

Dual-channel vs quad-channel

FREQUENCY? BANDWIDTH? DUAL- AND QUAD-CHANNEL?

What's going on? In reality, maximum performance is a combination of four factors: the base clock frequency at which the memory operates, the number of data transfers possible per clock (DDR means double data rate), the width of each channel or memory bus (64 bits), and the number of channels used to transfer data to and from the CPU.

Say we have a 16GB kit (2 x 8GB) of dual-channel DDR4, with a base frequency of 1,600MHz. We can do the following calculation to figure out how much memory bandwidth we have. We take the 1,600 (MHz), break that down into Hz (1,600,000,000), and multiply it by the data rate (2) to get 3,200,000,000, aka 3,200MT/s (or 3,200MHz if you're in marketing). Multiply that by 64 (the width of each channel in bits), and multiply that by 2 (the number of channels), and we're left with the final figure in bits per second. Divide that by 8 for bytes, and it's 51.2GB/s, which is the maximum amount of data that can be transferred to and from your memory modules at any time. For quad-channel, you double that figure.

The important thing to note here is that no matter how many sticks of memory you have installed in your system, the CPU can only write or read from however many channels it supports at one time, so for mainstream platforms, that's two. You could have four sticks installed in a dual-channel system just fine, but all you're essentially doing is increasing the maximum memory capacity of your rig, enabling you to store more data in your DRAM — it's not faster than just running two.

As far as video editing is concerned, the more bandwidth you have, the better, especially if you're working on 4K video and higher, because those files and frames are often stored directly in DRAM, and it's very easy to bottleneck a system that way.

Graphics bottlenecks

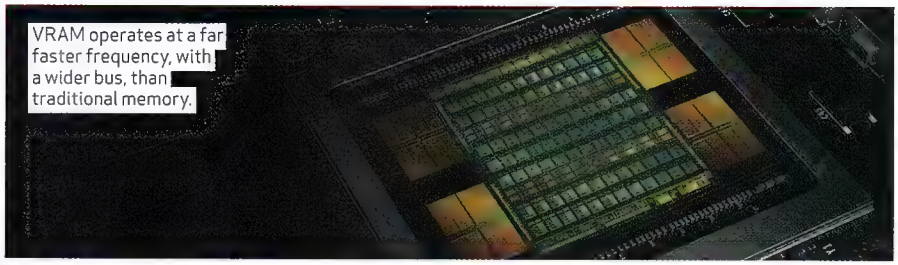
The wonderful world of VRAM and how a GPU does what it does.

Memory is also a vital component when it comes to rendering graphics, both with integrated and dedicated GPUs. It all comes down to the notion of a frame buffer. In short, the GPU cores found in both graphics cards and CPUs rely on the frame buffer to store rendered textures, which can be called upon, when required, for quick, smooth and efficient rendering, and the piecing together of frames in game. For a standalone GPU, the card itself features its own dedicated memory, designed specifically with that one task in mind. These memory chips typically run faster than their DRAM counterparts, and have a wider bus, which allows for a larger amount of data to pass through at any given time.

For instance, an Nvidia GTX 1080 has a 256-bit bus, with its GDDR5X chips running at a base clock frequency of 5GHz (or 10GT/s), and can transfer up to 320GB/s of data to and from the memory found on the graphics card itself – and that's all off a single channel (dual-channel is rumoured to be coming with GDDR6).

Integrated graphics run off a very similar system, with both Intel and AMD's latest APUs featuring far smaller capacity memory located on the CPU's integrated GPU, and it acts in exactly the same manner.

The big problem for GPUs, however, is when the total dedicated VRAM storage capacity becomes saturated. It's not the width of the bus that's the problem, but more the total capacity not being big enough to hold all the high-definition textures and pre-rendered frames necessary to smoothly render the frames in the game you're playing. In this situation, the GPU offloads any remaining texture files on to traditional DRAM, which is far slower than its VRAM counterpart. These files have to be transferred across from the GPU to the CPU, and then to the DRAM, before going back again when they're needed. This increases CPU utilisation, bumps up texture load times, and increases frame latency as the data has to go back to the GPU via the CPU. This is where you begin to get your memory bottleneck, and why, on occasion, you'll find GPUs with cores capable of driving games at two separate resolutions, often coming with multiple VRAM configurations.


VRAM operates at a far faster frequency, with a wider bus, than traditional memory.

LOAD RATIOS AND 4K

When it comes to GPU core performance, resolution and frames per second play a big part in overall system load. Generally speaking, the higher the frame rate, the harder the CPU has to work to process all that information effectively, and the easier it is for your CPU to become the bottleneck in a system. As the resolution increases from 1080p to 4K, that load is then offset to the GPU, and the graphics core spends more time rendering each scene (due to that 300% increase in the number of pixels). Because of that, the load shifts away from the CPU and on to the GPU, and simultaneously frame rates fall, because the GPU simply can't keep up.

This is important to understand, because a GTX 1080 Ti and Core i3-8100 combo is more likely to work better at 4K than at 1080p, so far as bottlenecks are concerned.

Overcompensating

HAVING READ THE ABOVE, YOU SHOULD NOW HAVE SOME UNDERSTANDING OF JUST HOW IMPORTANT IT IS TO BUY THE RIGHT GPU FOR THE RESOLUTION YOU WANT TO TAKE ADVANTAGE OF, AND THE GAMES YOU WANT TO PLAY.

Memory and GPU cores are typically well paired. A GTX 1060, for example, combined with 3GB of VRAM, is more than enough for 80% of most modern triple-A 1080p titles, with 6GB of VRAM being enough to futureproof you for the next four years, or just enough to scrape by on for 1440p.

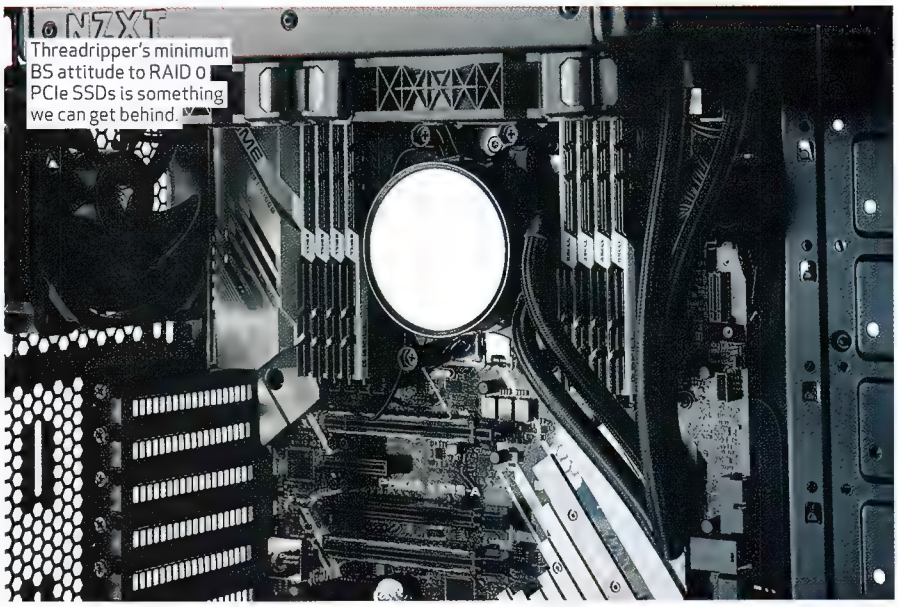
The big problem, however, lies with the folk who drop the cash on a GTX 1080 Ti, only to then game at 1080p. Unless you're absolutely obsessed with playing first-person shooters at 200Hz and above, with super-low latencies, such a purchase makes little sense from a consumer standpoint. Even if you roll with the notion of it being part of a smart futureproofing decision, the reality is that HD textures are highly unlikely to reach 11GB in size any time soon, and even if they do, by that point, 1080p will be positively antiquated technology in comparison to both the GPUs and the resolutions of the future.

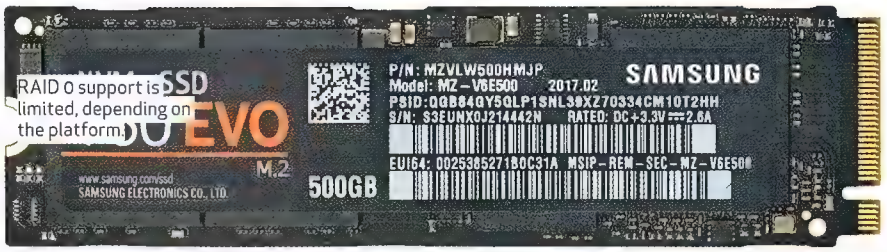
4K shifts most of the load away from the CPU and on to the GPU instead.

Storage chokes

Your choice of platform dictates whether or not you can run a RAID.

Storage solutions are the next biggy on our list of bottleneck conundrums, and the issue pretty much boils down to the introduction of the latest PCIe SSDs, from the likes of Samsung, causing problems for those interested in setting up multiple drives in RAID 0. Traditionally, when you wanted more speed from your system, the obvious way to do this was to take two hard drives – spinning platters or flash SSD – and set them into a redundant array of independent disks with striping. You'd take two drives, and force the data saved to be split in half and written to both simultaneously. Then you could read the original data from both drives at the same time, effectively doubling performance, in exchange for a little more vulnerability, because if one drive fails, half your data is gone.





PCIE SSD RAID 0?

The big question is: can you do that with PCIe SSDs? The answer: technically, yes, but you won't gain any performance out of it. At least, not from most mainstream platforms (check out our results on page 60). The problem derives from how both Intel and AMD have configured the use of their chipsets and storage I/O, and it's all to do with the PCIe lane interconnects. Let's break it down.

Intel's mainstream platform takes advantage of what's known as a DMI (direct media interface). Briefly speaking, this is a direct connection between the CPU, the PCH/chipset and the I/O storage devices in your system (SATA, USB, and M.2 SSDs). From Z170 onward, Intel has been using DMI 3.0, which is essentially four PCIe 3.0 lanes. What that means is that the maximum throughput from the chipset to the CPU via the DMI is currently 3.93GB/s (or 3,930MB/s).

All of a sudden, it's easy to see what's causing your bottlenecks when running twin M.2 PCIe SSDs in RAID 0, because there's simply not enough bandwidth to allow for a straight doubling of performance, as was possible with SSDs and HDDs through the SATA interface and DMI 2.0 (maximum throughput about 2GB/s).

AMD's Ryzen architecture runs things differently. The PCH to CPU interconnect actually only runs four PCIe 2.0 lanes, similar to Intel's original DMI 2.0, as opposed to DMI 3.0's four PCIe 3.0 lanes we see today. However, that's dedicated to onboard USB 3.1/0 and USB 2.0 devices. This is because although both Intel and AMD's processors reserve 16 PCIe 3.0 lanes directly for graphics solutions, AMD also reserves an additional four PCIe 3.0 lanes directly to the CPU for PCIe SSDs and SATA drives, with no interim chipset adding latency to the affair.

That said, it's still only four PCIe 3.0 lanes, and a 3.93GB/s max transfer rate between the CPU and its storage, meaning again, there's just not enough bandwidth.

WHAT ABOUT THE HIGH END?

At the high end, both platforms change things up quite dramatically. As both teams field processors with more and more dedicated onboard CPU PCIe 3.0 lanes (Intel's top-end chip offers a fruity 44, while Threadripper's entire range throws up 64 in total), it is indeed possible to run PCIe SSDs directly off the CPU, as opposed to running them through the chipset and DMI.

Despite Intel having multiple PCIe lanes on its chips, it hasn't supported RAID on PCIe SSDs until very recently. With Skylake-X, it introduced VROC (Virtual Raid on CPU) for the first time, allowing PCIe SSDs utilising those direct CPU PCIe lanes to theoretically form a RAID directly on the CPU itself. However, there's a few caveats to this. Firstly, you need a VROC key – this is a physical dongle that you plug in to the motherboard to enable the feature. It's not possible to buy these separately from an official retailer, because they're typically only bundled with specific motherboards and SSDs (although you can buy one from a third party for roughly $180). And once that hoop has been jumped through, you can also only use Intel SSDs for VROC, which limits you to Intel's Optane 760P SSDs, which are hardly mind-blowing when it comes to storage.

On the flip side, AMD's Threadripper series packs a whopping 64 PCIe lanes directly on the chip itself, allows you to RAID whatever you like directly on the CPU without any proprietary nonsense, and is realistically the most sensible platform, where you'll see sequential speeds bounce up because of it.

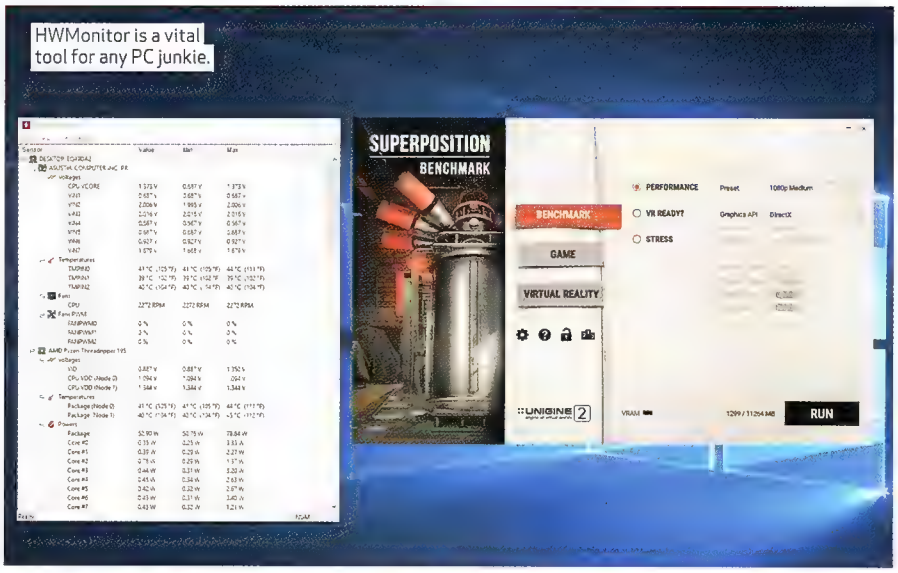
Testing time

Let's fire up some software, and perhaps a spreadsheet or two, and figure out where exactly your bottlenecks are occurring.

CPU

There are a few obvious bottlenecks we're going to ignore, as they're processor limitations. For instance, video editing benefits from more cores and higher single-core/IPC. But the biggy is in game. Go to **www.cpuid.com** and download HWMonitor (dodge the Pro version), run that, and minimise everything aside from the 'Utilization' section for your processor and graphics card. Here, you'll see all your threads, and their current, minimum and maximum utilisation, along with your GPU utilisation. Load up the gaming benchmark of your choice (Unigine's Superposition is a solid alternative at **benchmark.unigine.com**), then 'Alt-Tab' back to HWMonitor, select the View drop-down, hit 'Clear Min/Max', then go back to your benchmark and hit Run.

You're looking for whether your CPU load is at 100 percent across all threads while your GPU load is at about 60–70 percent. If it is, you'll want to look at upgrading that CPU to something with a little more grunt. We recommend a minimum of an Intel Core i3-8100, or a Ryzen 3 1300X.



HWMonitor is a vital tool for any PC junkie.

GPU

Again, the obvious bottleneck with the GPU comes from a lack of core performance for the resolution you want to play at. You want to hit around 40fps in game to have something of an enjoyable experience; 60fps is the sweet spot, but it's not the end of the world if some titles don't reach that—it's not suddenly unplayable. There's a ton of ways to see frame rates in game; some titles support it as an option, but if that's not possible, you can download a trial of Fraps (**www.fraps.com**), which includes a visual fps overlay to allow you to see your frame rate in the corner of the screen.

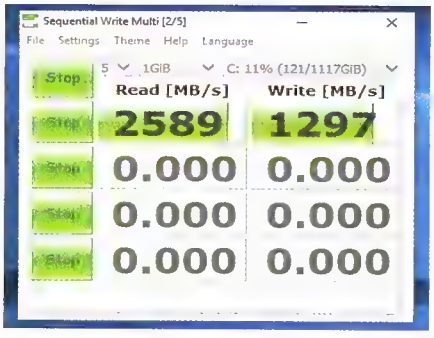
We can test whether a lack of VRAM is bottlenecking your system by using HWMonitor and the game you're having difficulty with. Keep HWMonitor open and those utilisation windows up, and play the game you're having difficulty with. If you notice the memory is maxing out at 100%, either reduce the resolution of the textures, or opt for a newer GPU.

In-game fps overlays make figuring out performance woes far easier.

SSD

And finally, we have the wonderful world of solid-state bottlenecks.

Unfortunately, as we've already discussed in depth, anyone who's running more than one PCIe SSD in something like a RAID 0 array – unless you're running those devices in a Threadripper motherboard and have gone about extensively setting up the array for them – the brutal truth is that you're bottlenecking both drives, while simultaneously increasing your risk of data loss. CrystalDiskMark is our go-to benchmarking software for this challenge, so head to **crystalmark.info** to download the latest version of our favourite SSD benchmark, then it's simply a case of running the QD32 Sequential speed test on the drive or array in question to identify just how fast it's running. If you're running multiple PCIe drives on any mainstream board, it may also be worth checking to see whether all your M.2 slots are running in PCIe mode, and not SATA – after all, you don't want a 3,000MB/s drive to be capped at 550MB/s because of the SATA interface.



Our favourite SSD testing utility by far.

Case studies

Let's look at a few rigs we've specced together with obvious flaws.

INGREDIENTS	
CPU	INTEL CORE I3-3240
COOLING	STOCK
MEMORY	8GB (2 x 4GB) DDR3 @ 1,600MT/S
GPU	2 x GTX 970
MOTHERBOARD	GIGABYTE GA-Z77X-UP5 TH
SSD	120GB SAMSUNG 840 EVO
HDD	1TB WESTERN DIGITAL 7200RPM
PSU	550W CORSAIR TX550M

THE ANCIENT GAMER

There are two major problems here, the first of which is the dual GTX 970s running in SLI. This forces the GPUs to operate in PCIe x8 mode, as opposed to a full-fat x16. Couple that with the fact you've got just a dual-core processor, and most games are immediately going to throttle even at 1080p.

The GPU solution is fine on its own for 1080p, but the problem lies with that processor. It would make sense to upgrade the motherboard and CPU to something with more cores and single-core grunt.

The second and possibly more alarming problem is the 550W bronze-rated power supply. By default, you should be drawing around 450W from the wall – even with this dual SLI setup – but only having 100W of headroom doesn't fill us with confidence if things spike under extreme load. Worst case scenario: the power supply can pop, and take parts with it. Best case: it just won't power on under those circumstances.

INGREDIENTS	
CPU	AMD RYZEN 7 1700 @ 3.8GHZ
COOLING	STOCK
MEMORY	32GB (2 x 16GB) DDR4 @ 2,666MT/S
GPU	NVIDIA GEFORCE GTX 1080
MOTHERBOARD	MSI X370 GAMING PRO CARBON AC
SSD	1 x 512GB SAMSUNG 970 PRO
HDD	1 x 1TB SAMSUNG 960 EVO
PSU	700W BE QUIET! PURE POWER 10

THE EAGER PROFESSIONAL

In this scenario, the end user has taken a single Ryzen 7 1700 and ramped it up to 3.8GHz across all 8 cores and 16 threads. Which is fine – the 1700 is more than capable of handling those kind of voltages and frequencies. However, the biggest problem here is something we haven't covered so far, and that's thermal throttling, which in its own way is a very specific form of bottlenecking.

In short, as the temperature gets too high, if your processor is stable, it immediately begins to downclock itself, to ensure it doesn't damage any of the silicon at its heart. You may think it's running at 3.8GHz, and it may very well be at startup, but as soon as you get in game, or start running some computational tasks, that frequency is going to drop, just to keep the chip safe.

On top of that, this rig has multiple PCIe SSDs installed. The Samsung 970 Pro for the OS is directly installed on to the motherboard, and will operate just fine utilising those four dedicated lanes we spoke about earlier. The problem is the 1TB 960 Evo – although some motherboard manufacturers do allow you to run an additional PCIe SSD in an M.2 slot, they are usually forced to utilise the majority of the interconnecting lanes between the PCH and the CPU. In Ryzen's case, that's four PCIe 2.0 lanes, meaning maximum transfer rates of 2.0 GB/s. Not good.

INGREDIENTS	
CPU	INTEL CORE I9-7900X @ 4.7GHZ
COOLING	NZXT KRAKEN X72 360MM AIO
MEMORY	8GB (2 x 4GB) DDR3 @ 1,600MT/S
GPU	NVIDIA TITAN XP
MOTHERBOARD	ASUS PRIME X299 DELUXE
SSD	1 x 250GB SAMSUNG 960 EVO
HDD	1 x 1TB CRUCIAL BX300 2.5-INCH
PSU	1,200W CORSAIR AX1200I

THE EPEEN STREAMER

In our final selection, we have a combo designed to make any tech journalist flinch. The issue here isn't that obvious at first glance, but it all comes down to the motherboard and CPU combo, combined with that hefty overclock. Although the Core i9-7900X is aptly cooled by the 360mm AIO to an impressive 4.7GHz overclock, the problem lies with the VRMs on the motherboard. There's too much voltage being pushed through them, and not enough heatsink to provide them with sufficient cooling. In short, the mobo's BIOS is forced to reduce the voltage to keep temperatures within acceptable parameters.

Although the CPU may well register at 4.8GHz, and be operating at 100% utilisation, the actual performance can be even lower than stock in some cases. The best way to spot this is by installing HWInfo, and analysing your VRM temperatures – anything above 110°C when under load is bad news. Run Cinebench R15 at stock and then at your overclock settings, and if you're noticing a drop in score without a drop in utilisation or registered clock speed, you know it's the VRMs causing the issue.

There are two solutions. You can either drop back on the voltage, or opt for a beefier cooling solution, one that directly cools the VRMs. EKWB and some other aftermarket liquid-cooling companies offer full-cover monoblocks for both the VRMs and the CPU on most mainstream motherboards.

Bottleneck results

Exactly how do different setups affect your performance?

HOW WE TESTED

Obviously, we no longer have a lot of the old hardware we've featured below, so much of this is synthetic, rough benchmarking, utilising a Core i7-8700K. The theory is fairly simple: We found our old Cinebench R15 single-core figures for everything back to Sandy Bridge, and declocked the Core i7-8700K to the point at which we achieved similar, if not identical, scores to the old processors. At that point, we disabled a variety of cores and/or Hyper-Threading, depending on the configuration of the part we were trying to emulate at the time.

Other than that, our test rigs included 16GB of DDR4 for our mainstream platforms, operating at 3,200MT/s, and 32GB of DDR4 for our X399 and X299 RAID testing. Our PCIe SSDs of choice consisted of dual Samsung 960 Pro 512GB SSDs, operating through onboard M.2 slots, or ASUS's included RoG Zenith adapter. As for mobos, our Intel games and RAID testing featured MSI's Z370 Godlike Gaming. For Ryzen RAID testing, we plumbed in our recent MSI X470 Gaming M7 AC. For our Intel RAID testing, we took advantage of the ASUS Prime X299 Deluxe, and for Threadripper RAID testing, we grabbed our trusty ASUS X399 RoG Zenith Extreme, in combination with the included PCIe SSD adapter.

> "All games were tested at the Ultra preset, with HD textures. 3DMark's Sky Diver was run at default for 1080p, and then adjusted to 4K for the 4K testing."

All games were tested at the Ultra preset, with HD textures. 3DMark's Sky Diver was run at default for 1080p, and then adjusted to 4K for the 4K testing. The DNC runs for the Core i3-2120 in *Assassin's Creed: Origins* were actually to do with how the benchmark performed. It genuinely did complete each run, but there was massive lag in loading textures, with wire meshes and HD textures taking an eternity to load – if at all. As the scenes became more complex, frame stuttering occurred, and although the frame rate remained high, it was clear that this isn't how the benchmark was meant to run.

INTEL CORE I7-8700K CLOCK SPEEDS & CORE SETUP

	CINEBENCH R15 SINGLE-CORE (INDEX)	FREQUENCY/ACTIVE CORES
INTEL CORE I3-2120	80	3.1GHZ/2+2
INTEL CORE I5-3570	132	3.2GHZ/4+0
INTEL CORE I7-4790K	169	3.7GHZ/4+4
INTEL CORE I3-8100	154	3.6GHZ/4+0
INTEL CORE I7-8700K	190	N/A

SSD RAID 0 TESTING (2 x SAMSUNG 960 PRO 512GB)

	CDM SEQ READ	CDM SEQ WRITE	CDM RANDOM 4K READ	CDM RANDOM 4K WRITE
INTEL CORE I7-8700K	3,456 MB/S	2,170 MB/S	49 MB/S	138.3 MB/S
AMD RYZEN 7 2700X	3,066 MB/S	2,006 MB/S	49 MB/S	123.7 MB/S
INTEL CORE I9-7900X	3,157 MB/S	2,165 MB/S	43 MB/S	183.32 MB/S
AMD RYZEN 7 THREADRIPPER 1920X	5,912 MB/S	3,859 MB/S	38 MB/S	180.2 MB/S

NVIDIA GEFORCE GTX 1060 3GB (AVG FPS) @ 1080P

	ASSASSIN'S CREED ORIGINS	MIDDLE EARTH: SHADOW OF WAR	3DMARK SKY DIVER
INTEL CORE I3-2100	58 (DNC)	74	17,091 (INDEX)
INTEL CORE I5-3560K	54	74	21,563 (INDEX)
INTEL CORE I7-4790K	58	73	26,943 (INDEX)
INTEL CORE I3-8100	57	74	23,182 (INDEX)
INTEL CORE I7-8700K	58	72	32,900 (INDEX)

NVIDIA GEFORCE GTX 1060 3GB (AVG FPS) @ 4K

	ASSASSIN'S CREED ORIGINS	MIDDLE EARTH: SHADOW OF WAR	3DMARK SKY DIVER
INTEL CORE I3-2100	24	26	11,310 (INDEX)
INTEL CORE I5-3560K	24	26	15,632 (INDEX)
INTEL CORE I7-4790K	24	26	17,098 (INDEX)
INTEL CORE I3-8100	24	26	16,581 (INDEX)
INTEL CORE I7-8700K	24	26	17,033 (INDEX)

NVIDIA GEFORCE GTX 1080 TI 11GB (AVG FPS) @ 1080P

	ASSASSIN'S CREED ORIGINS	MIDDLE EARTH: SHADOW OF WAR	3DMARK SKY DIVER
INTEL CORE I3-2120	65 (DNC)	92	19,286 (INDEX)
INTEL CORE I5-3570	65	119	27,547 (INDEX)
INTEL CORE I7-4790K	84	120	37,042 (INDEX)
INTEL CORE I3-8100	67	122	29,496 (INDEX)
INTEL CORE I7-8700K	98	123	49,871 (INDEX)

NVIDIA GEFORCE GTX 1080 TI 11GB (AVG FPS) @ 4K

	ASSASSIN'S CREED ORIGINS	MIDDLE EARTH: SHADOW OF WAR	3DMARK SKY DIVER
INTEL CORE I3-2120	54 (DNC)	51	11,066 (INDEX)
INTEL CORE I5-3570	49	51	16,303 (INDEX)
INTEL CORE I7-4790K	51	51	22,582 (INDEX)
INTEL CORE I3-8100	52	51	17,340 (INDEX)
INTEL CORE I7-8700K	52	51	31,383 (INDEX)

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THE FUTURE OF LINUX

Which distributions will we be using in the years to come? Paul O'Brien investigates — and wonders if the alternatives in the Linux world mean it could feel very different in the future.

As time progresses, Linux continues to mature and become increasingly powerful for all types of users. From the desktops of those of us who prefer to use the open source OS as our daily productivity platform to powering millions of servers on the internet, it touches virtually everybody's daily lives, even if they don't realise it. Despite the popularity of Ubuntu, the Linux family continues to provide a rich variety of alternative offerings for all types of users, many of which show great promise for the next generation of Linux.

One growing trend within Linux distros is to be less of a jack-of-all-trades but instead to offer a more tailored experience based on a specific use case. Linux's roots are well represented, with a wide range of 'expert' distros for security researchers, developers, artists, musicians and educators to name just a few. But general-purpose distros also remain popular and Linux is more accessible and polished than ever before. This makes it easy for beginners to get started, and ensures that the visual experience of using something other than Windows or MacOS no longer feels second-class.

In addition to the core distro, we are already seeing advancements in the realm of package distribution which mean that, for those who are new to Linux, installing and uninstalling applications will be a much more pleasant experience. Of course, even for those of us who are expert users, any improvement in this area is very welcome. Flatpak and Snap packages have the potential to genuinely revolutionise Linux (particularly on the desktop), marking a change that has been desperately needed on the platform for a long period of time – from both user and developer perspectives. If installing an application is easier and developing and packaging an application is much easier, too, everybody wins.

Exactly how we use Linux distributions is gradually changing over time. The container revolution driven by Docker and Kubernetes is well under way, fundamentally changing how Linux is used in the server world. Virtualisation on the desktop continues to improve too both at the hardware level and in software, making the use of multiple OSes concurrently a much more appealing proposition than it was a few years ago.

Even Microsoft offers Linux virtualisation on Windows, which would have been unthinkable just a year or two ago. This same hardware-level virtualisation technology is driving improvements in personal security – particularly valuable as users are increasingly conscious of the safety of their data.

So what does the 'next gen' hold? In the coming years, you may or may not be running a different version of Linux to the one you're using today, but it's likely that how it works under the skin, how it looks, how easy it is to set up and use, and how safe your data is may evolve considerably from what things look like today. Let's examine some of the possibilities that the future holds, given the trends we're seeing today...

AT A GLANCE
Where to find what you're looking for.

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IT JUST WORKS!
Distributions that 'just work' out of the box are vital to Linux's future and will help shape the next generation, but there's still room for more technical offerings, too.

PAGE 64
ACCESSIBLE AND BEAUTIFUL
A sensible set of initial applications and design to rival commercial OSes are becoming widespread. Linux general app support is key, too; the continuing improvement of apps such as LibreOffice helps.

PAGE 65
CHROME-OS INSPIRED
Linux-based Chrome OS has been far more popular than anticipated, inspiring Chromium OS-based spin-offs and conventional Linux-based homages.

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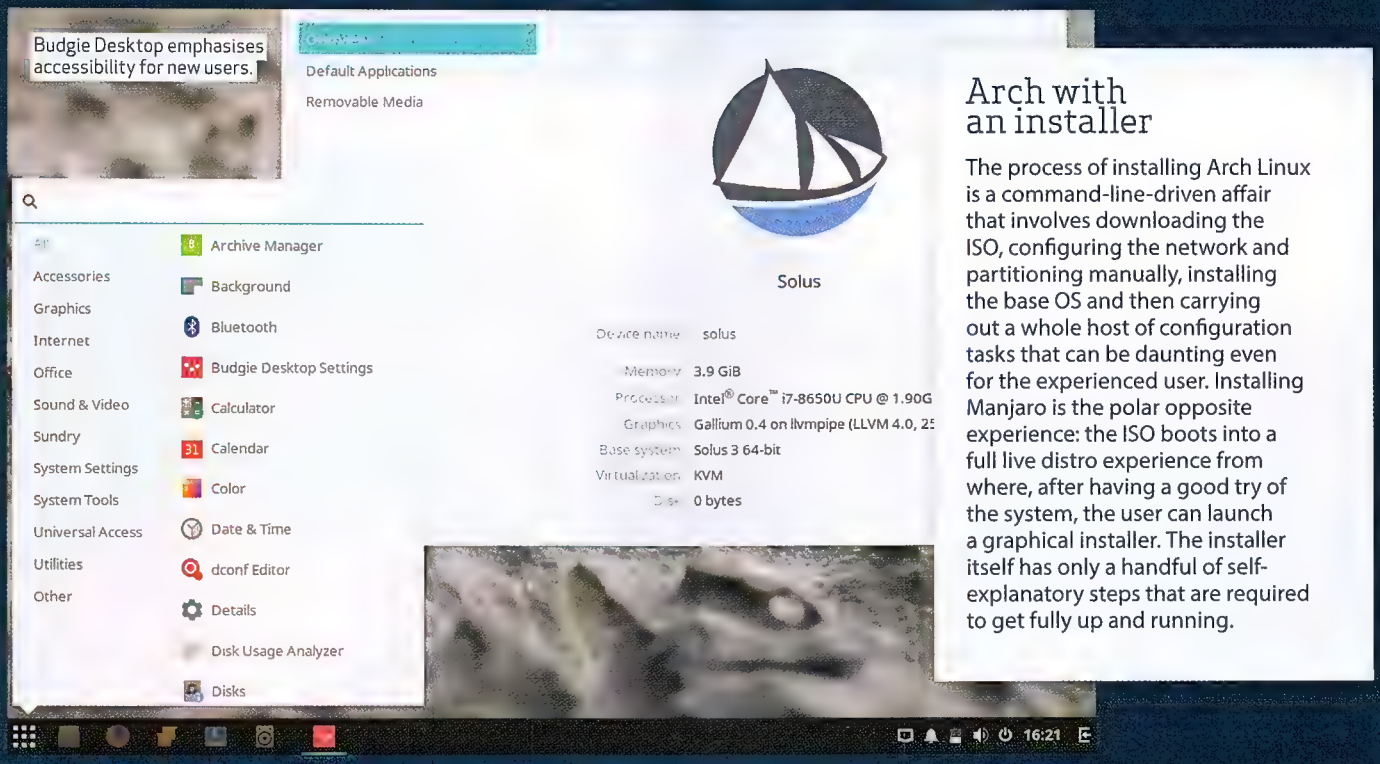
SAFE AND SECURE
Distributions with a focus on security offer differing levels of protection, from ultra-secure options to slightly tweaked versions of the main popular distros. User awareness of security is growing.



Arch with an installer

The process of installing Arch Linux is a command-line-driven affair that involves downloading the ISO, configuring the network and partitioning manually, installing the base OS and then carrying out a whole host of configuration tasks that can be daunting even for the experienced user. Installing Manjaro is the polar opposite experience: the ISO boots into a full live distro experience from where, after having a good try of the system, the user can launch a graphical installer. The installer itself has only a handful of self-explanatory steps that are required to get fully up and running.

It just works!

Linux distros that 'just work' on a wide variety of hardware take the OS beyond the developer audience.

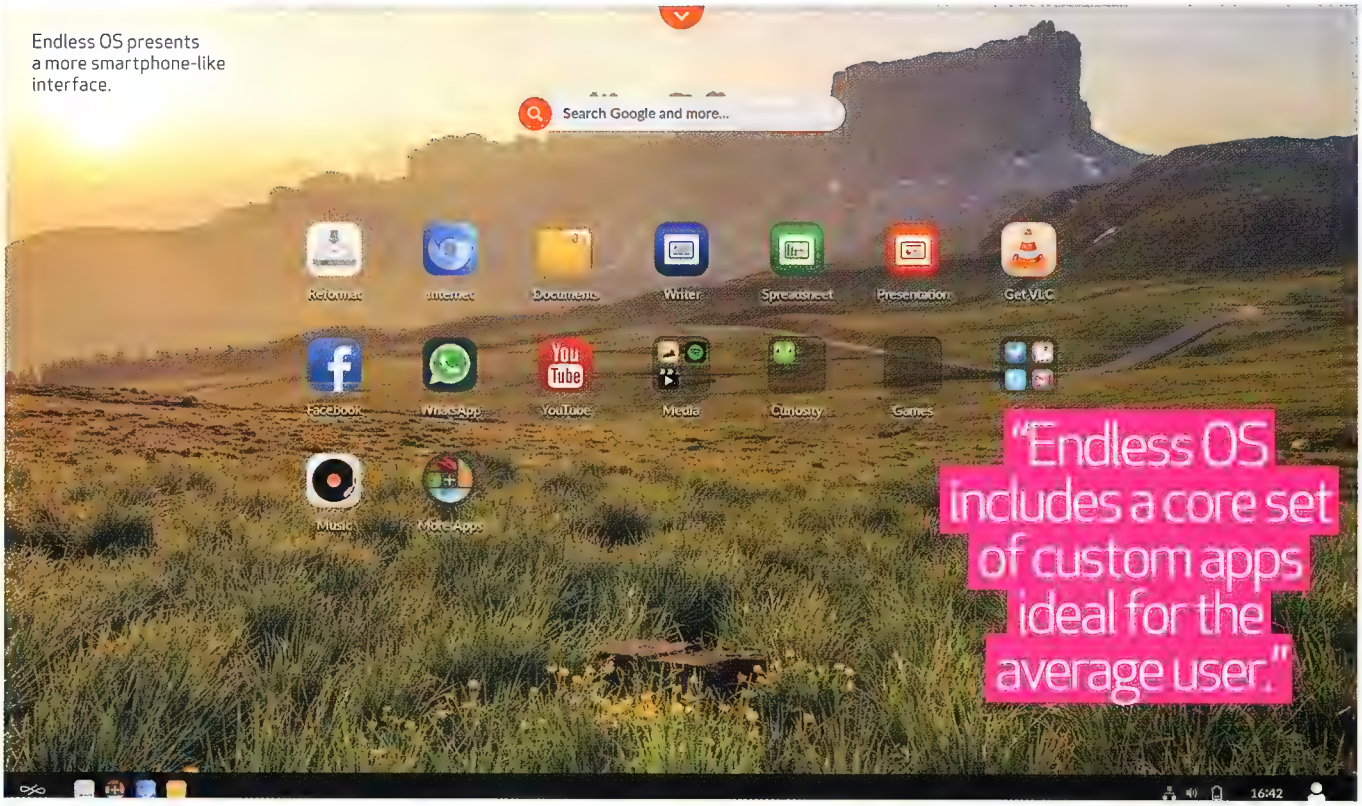
One question that's sure to polarise the opinion of Linux fans is 'Does it matter if Linux is difficult to set up and use?'. Linux's roots are obviously among users who can – and even choose to – get deep down and dirty with the internals of a system to get it up and working, and get it working well. While this is all well and good, it creates a barrier to entry – perceived by some as no bad thing, but by many others, this is a fundamental problem for Linux. Great strides have been made in this area in recent years, and improvements will continue for next-generation distros.

Solus (**solus-project.com**) is a great example of a distro that is designed to 'just work'. Designed for home computing use, Solus provides several tailored experiences so that, out of the box, anyone can get up and running – whether they have modern hardware (in which case, the Budgie desktop is used) or older machines (in which case, it's MATE). A Gnome option is also available. Solus ships with a well-rounded suite of apps for office users, developers, gamers and content creators, plus an easy-to-use software centre, and is provided as a curated rolling distribution, making the update process easier and maintaining stability. Solus is unique in that it's built from the ground up rather than being based on another distro.

Installation is easy and quick, it's fast and well-designed in use, and epitomises the 'just works' mantra, perhaps too well for some – if you like to tinker, Solus probably isn't for you!

When choosing an accessible Linux distro, the last place you would probably look is Arch, which puts off all but the most hardened of Linux fans at the installation stage. This is a shame, because Arch is a great distro. Enter Manjaro Linux (**manjaro.org**), providing all the benefits of its Arch base but with a focus on user-friendliness and accessibility. As such Manjaro is suitable for beginners, as well as experienced Linux users. Available in Xfce, KDE and Gnome versions, like Solus Manjaro uses a rolling-release model. If the next-gen brings Arch to the masses, it's likely to be Manjaro that makes it possible.

Pamac is used for package management on the Xfce version of Manjaro.
Welcome to Manjaro!
TOSHIBA
"Solus ships with a well-rounded suite of apps for office users, devs, gamers and content creators."



Endless OS presents a more smartphone-like interface.

Accessible and beautiful

Linux innovation goes beyond the internals with new, beautiful, accessible distributions to challenge the prettiest alternatives.

While the 'just works' distros are gaining in popularity and look set to play a big part in the future of Linux, other distros are taking a different approach. These are going beyond a focus on core functionality and the initial setup process by looking at both the visual aspects of the distro and the simplicity of the experience for a specific type of user.

The leading example of this today – and a distro that has dramatically increased in popularity – is elementary OS (**elementary.io**). Right from the off, elementary is touted as a "fast and open replacement for Windows and Mac OS". Elementary is based on Ubuntu LTS and includes the Pantheon desktop environment. Aside from a beautiful visual style that will feel particularly familiar to Apple converts, elementary includes just a core set of custom apps with the ideal functionality required for the average user, together with the AppCenter, which focuses on simple app discovery and installation, as well as offering a 'pay what you want' paid-app model for indie developers.

Endless OS (**endlessos.com**) is another distro that takes a similar approach, trying not to overwhelm out of the box but skewing to a more specific use case. Endless intends to be an all-round distro that also offers educational tools to a modern family. Although over 100 apps are included, specific steps have been taken to avoid this feeling overwhelming by basing the custom UI on a Smartphone paradigm, something that will feel instantly familiar to most users. Endless is built on Debian and is also available pre-installed on Endless Computer hardware.

DISTRO SPOTLIGHT

Other forward-thinking distros.

ANTERGOS

Antergos is another option based on Arch Linux, adding a graphical installer to the distro. It focuses on simplicity, offering a fully configured OS with sensible defaults to get started right away. It uses the Numix theme for a fresh, modern appearance.

LINUX MINT

Linux Mint's goal is to produce a modern, elegant distribution blending ease of use with powerful features. Based on Ubuntu, it's designed to be ready to go from the off. Community-driven development means a thriving user base and growing popularity.

NITRUX OS

Nitrux is a relatively new Linux distribution which focuses on design. It's based on Ubuntu but features Nomad desktop, which is built on KDE Plasma 5 and Qt. Other major features include a built in-firewall, Snap-based software and semi-rolling release model.

Chrome-OS inspired

The success of Chrome OS has led to distributions that mimic its ultra-light, web-focused approach.

When Chromebooks first launched, many scoffed at their chances of making a significant impact on the computing world. After all, who would really want an OS that basically only runs a web browser? Well, as it turned out, quite a few people did.

Chrome OS is still growing in popularity, particularly in the low-cost and educational markets, and its simplicity and Material Design visuals certainly appealed to more people than expected. Given this success, it's no surprise that Linux developers have seen fit to follow suit with distributions that echo the Chrome OS approach.

Of course, Chrome OS itself can be installed courtesy of Chromium open-source-based project releases such as the impressive Neverware CloudReady (**www.neverware.com**). Neverware also recently acquired the developers of Flint OS, a similar product which offers Chromium OS for non-Chromebook devices. One distro taking a slightly different approach is Liri (**liri.io**). Based on Arch – which is clearly growing in popularity as a base for other projects – Liri is currently at the alpha release stage and intends to make use of Google's Material Design in a traditional Linux environment, implementing it within the very latest software frameworks. The result is an OS that, while still in its early stages and absolutely not suitable as a daily driver as yet, looks set to be a contender for the next-gen crown.

Another impact of Chromebooks is that they provide access to cheap, high-quality hardware that's more than capable of running most Linux distros. If you have a Chromebook, you can either stick with Chrome OS and run Linux using a utility such as Crouton, or ditch the factory-installed OS completely and install an alternative such as GalliumOS (**galliumos.org**).

Gallium is a Xubuntu-based distro that incorporates specific tweaks and fixes to enable it to run well on Chromebooks, including an improved trackpad driver and device-related bug fixes. The result is impressive: it's less restrictive than Chrome OS, but with most of the benefits.

DISTRO SPOTLIGHT

Other forward-thinking distros.

ANDROID-X86

Linux underpins the world's most popular mobile operating system: Android. But its use isn't limited only to mobiles — you can run it on your PC, too, using this project.

BLISS OS

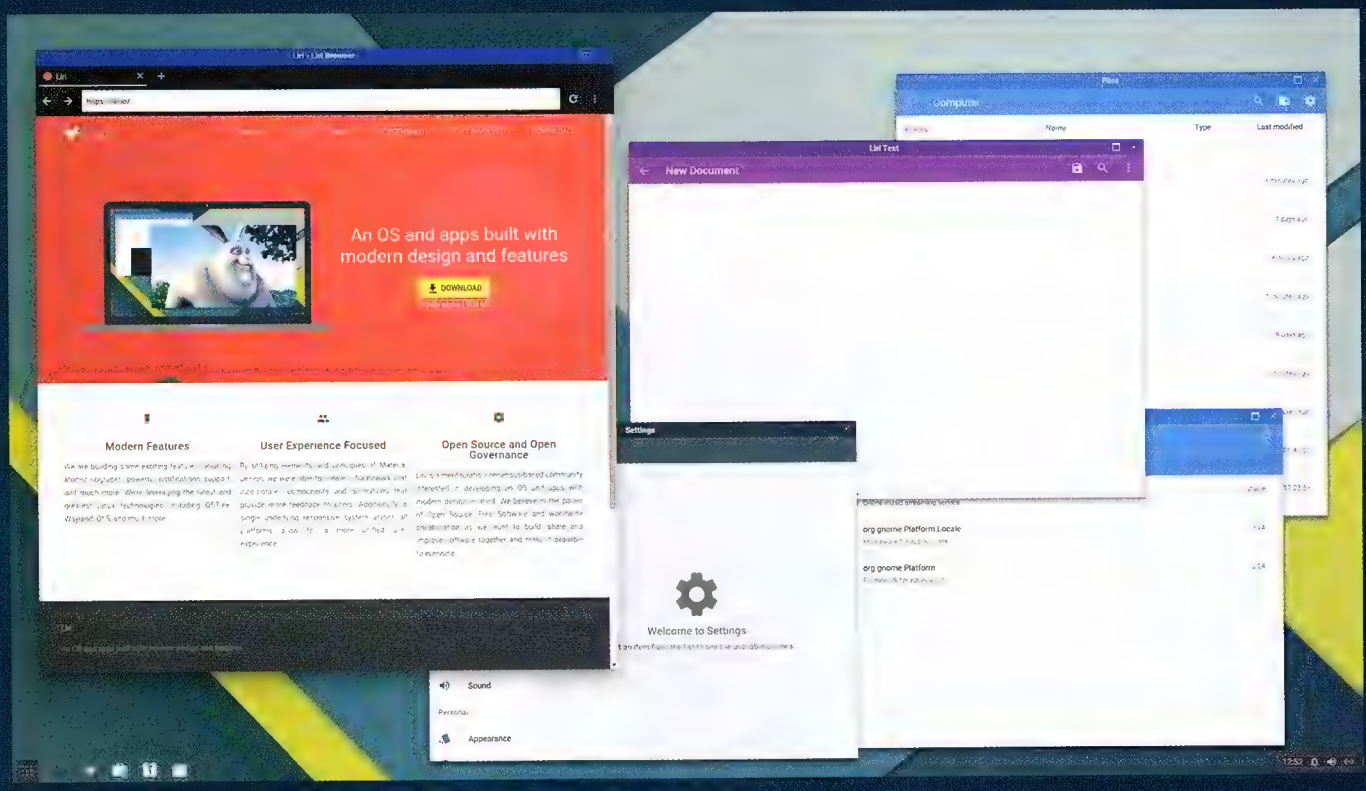
Android-x86 works pretty well on a computer, but Bliss OS provides an Android-based OS specifically optimised for laptops and desktops. The community-based release is surprisingly stable.

TAILS

Privacy is a growing concern, so it's not a bad idea to carry a bootable USB with a distro on it for using with unfamiliar PCs. Tails is ideal for this — it's entirely self-contained and leaves no trace on the PC.

SUBGRAPH OS

Subgraph OS is a hardened distro based on Debian Linux, designed to be particularly resistant to surveillance and interference by third parties. It's now in alpha.



Liri brings Google's Material Design to Linux, and looks likely to become more widespread.

Safe and secure

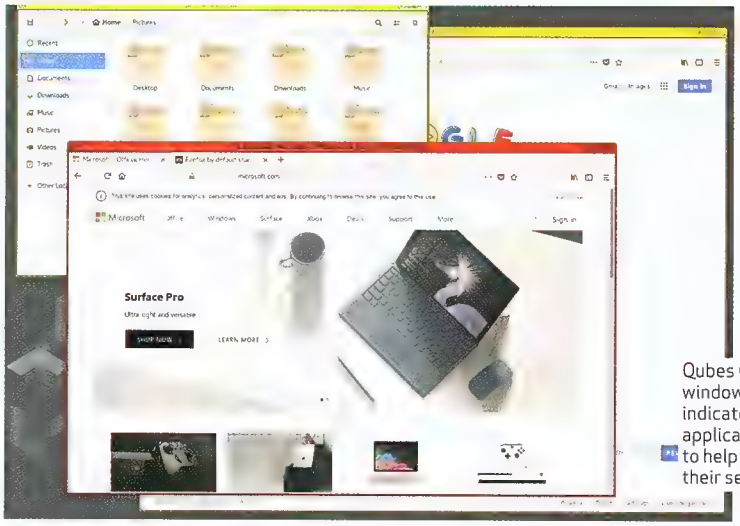
Safety and security are hot topics in today's always-connected environments, and Linux distros are reflecting this mindset.

When you're working on your computer, you expect your data to be safe. Even if you're not someone who is specifically at risk, you expect your operating system to look out for you. Until now, this hasn't really been a major focus – Linux has enjoyed something of a 'security through obscurity' resilience to attacks and together with the peer-reviewed security nature of open source, most mainstream distros haven't trumpeted their security features. This is slowly changing, however, with the introduction of distros such as PureOS (pureos.net).

PureOS is a Debian-based distro using the Gnome desktop environment which comes with leading privacy-protecting applications installed. Out of the box, you'll find Tor support, the DuckDuckGo search engine, the EFF's Privacy Badger and a custom web browser, PureBrowser, which includes built-in support for HTTPS Everywhere.

PureOS takes a very 'light touch' approach to privacy and security; it's far closer to a standard distro than Subgraph, for example, but also doesn't implement the same level of security. PureOS is available as a pre-installed option on several laptops from Purism, but intriguingly the team is also releasing a PureOS-based phone. Should Purism succeed in delivering a fully functioning phone OS later this year, it will have achieved something Canonical couldn't see through with its Ubuntu Touch project (see right).

At the other end of the spectrum, we have Qubes OS (**www.qubes-os.org**), the "reasonably secure operating system", which, despite the humble tag line, very much focuses on security. Qubes OS implements secure compartmentalisation using the Xen hypervisor – the same software relied on by many major hosting providers to isolate websites and services from each other. Each compartment, known as a qube, remains completely secure against cross-contamination from another Qube. ■

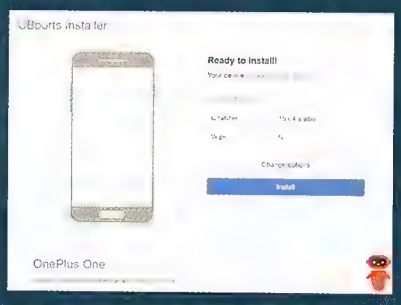


Qubes OS uses coloured window borders to indicate which Qube an application is running in, to help you understand their security levels.

PureOS maintains the feel of a conventional Debian/Gnome distro, but includes pre-installed privacy applications.

Is Ubuntu Touch dead?

Ubuntu Touch is a long-running effort to produce a touch-friendly phone and tablet version of Ubuntu. Begun in 2011, the project was canned by Canonical in April 2017 as the Ubuntu desktop distro moved back to Gnome. As is often the way with open source, however, the project lives on as it's been picked up by the UBports team (**ubports.com**). As well as continuing the development for phones and tablets, UBports is hoping to build the convergence product, which envisaged being able to connect a mobile device to a screen and keyboard and use it as a primary machine — an idea gaining popularity.



Although Canonical has killed Ubuntu Touch, it lives on through UBports.

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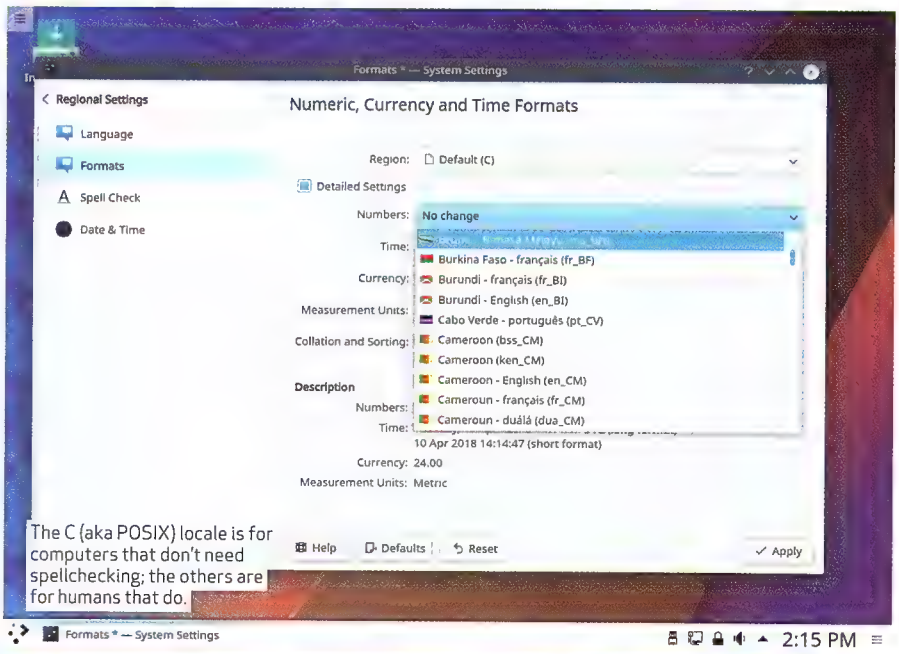
LINUX

UBUNTU TWO-STEP

I have a laptop that I use offline with Windows 7 and Ubuntu 14.04 on it. Besides those two OS partitions, I have two other NTFS ones (for data and VMs). My 14.04 install hasn't been updated since 2016. Am I right in thinking I can't apt upgrade my 14.04 install after 18.04 is released? How can I upgrade smoothly to 18.04?

I'm a newbie and don't really want to have to format the Linux partition and reinstall everything. My Wi-Fi seems to have stopped working with the captive portal at my library — could this be because the distro hasn't been updated in such a long time?

Oliver S



The C (aka POSIX) locale is for computers that don't need spellchecking; the others are for humans that do.

Good news, Oliver. Ubuntu 14.04 will be supported until April 2019 — the LTS releases come with five years of support. So you have a year to sort this out. That doesn't mean you shouldn't do anything, and at the very least, you should find a wired Ethernet connection and update your 14.04 install. It's very unlikely to break anything, and it might even fix your wireless connection. I can't help with that one anymore, not without knowledge of the hardware involved anyway, but I will say without hesitation that captive portal Wi-Fi is terrible and you should avoid it wherever possible.

You are quite correct: if you were to do a clean install of 18.04, you would need to reinstall all your programs (beyond things like LibreOffice and Firefox that are installed by default). It's also very likely that some of those programs are no longer present in the repositories, so you'd need to either compile and install these manually, or find some alternatives.

If you do want to upgrade to 18.04, then a clean install is probably the best way to go here, provided all the applications you need are still around. All you'd need to do would be to back up any documents you need from your home folder (or anywhere else on the target disk, an external hard drive is useful if you have a lot of data), do the install (your NTFS partitions can be left untouched), restore your backed up files, and install all the required programs. Even on an old laptop (as long as there's space) this shouldn't take more than a couple of hours. However, things rarely go according to plan, so it makes sense to allocate more time to the task.

"You may not want to upgrade to 18.04, at least not right away. It uses the Gnome desktop which, coming from Unity in 14.04, will require some getting used to."

An alternative route, one which doesn't involve wiping your hard drive, would be to upgrade first to 16.04. You may run into some difficulties here, or it may go smoothly. From here, you could either stick with 16.04 (which will be supported until 2021) or upgrade to 18.04. Again the upgrade may or may not go smoothly, and you would be left with a few relics of not one but two Ubuntus.

However, you may not want to upgrade to 18.04, at least not right away. It uses the Gnome desktop which, coming from Unity in 14.04, will require some getting used to. It may also not run nicely on old hardware. Upgrading to 16.04 may be the best option — it's cosmetically similar to 14.04. If it doesn't work, or you don't like it, then try a clean install of one of the lighter 18.04 flavours, Lubuntu, Xubuntu or Ubuntu MATE. I would hold off 18.04 for a couple of months, though.

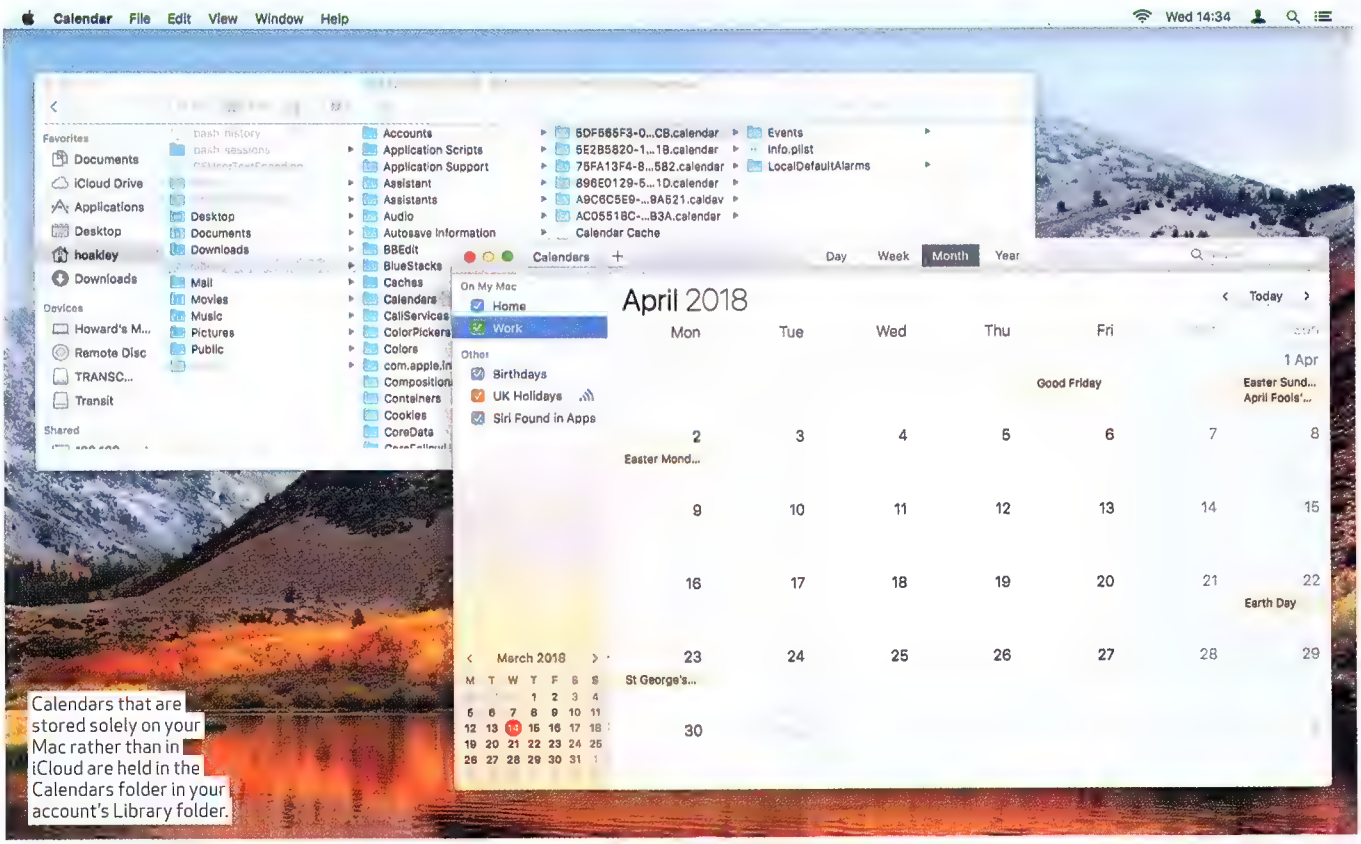
Jonni Bidwell

MAC

MISSING CALENDARS

When I replaced my old iMac, the shop transferred all my data to my new one. Several colour-coded calendars have disappeared in the process, and I can't find them on the new Mac. I don't use iCloud. Where have they gone?

Peter Whickman


Calendar File Edit View Window Help
Wed 14:34
Calendars that are stored solely on your Mac rather than in iCloud are held in the Calendars folder in your account's Library folder.

Data for calendars is stored in ~/Library/Calendars, with ~ meaning your account's Home folder. When the shop migrated the contents of your old Mac to the new one, that data should have been copied across and appear in this folder.

If you have a recent Time Machine or other backup of your old Mac, you should be able to restore the calendars from it. Quit Calendar, If you back up using Time Machine, open that app, browse to your Home folder, press 'Shift-Cmd-.' (fullstop) to reveal hidden items, and open the Library folder that was just revealed. Select the folder named Calendars, which contains all your local calendars. Navigate back through time until the missing calendars' files appear. Select them and click Restore. When you get back to the desktop, reopen the Calendar app.

If you don't have a Time Machine backup of your old Mac, only a copy of what was on it when you upgraded, perform the same task manually by copying and pasting files from that into your account's Calendars folder.

There are advantages to putting your Calendars in iCloud, most notable being easy access to them on all your devices. Although the local backups you make of your Mac will include your calendars, you should ensure that you keep offline backups of them; iCloud itself shouldn't be treated as a backup as changes, including damage to files, will propagate across all devices you connect to it.

Howard Oakley

LINUX

SPEEL CHCK PROBLM

I have an embarrassing problem. When I use LibreOffice in KDE Plasma, spell checking doesn't work. At first, I thought this was just my impeccable spelling, but colleagues started laughing at my work. Obviously, incorrectly spelt words are not underlined, and when I invoke the check manually it just says "The spelling check is complete", oblivious to my errors. If I dig around in the options, I can see some dictionaries installed, but in the actual Spelling dialog, the Text Language drop-down is blank. I'm using Arch, and have installed what I assume are all the required packages — hunspell, hunspell-en and hunspell-en_GB — but to no effect.

I know I have my system locale set up correctly (via /etc/locale.conf), which is confirmed when I run `localectl` ***on a TTY, but one thing I notice is that when I run that command in a KDE session, it tells me the locale is set to C, which is surely wrong. The theming seems to be wrong, even though I have the Breeze GTK theme installed and other GTK apps look fine. I've read somewhere about changing the SAL_USE_VCLPLUGIN environment variable, according to 'Help > About'. I'm using the Qt4 VCL already.***

Will D

Don't worry, your secret is safe with me and our thousands of readers. I have the same setup, and have run into exactly this issue. Regional settings are global throughout Plasma. You've probably already found the Language options ('System Settings > Personalisation > Regional Settings > Language') in which case you were close to solving this one.

Also in the Regional Settings is an option for Formats, which sets the locale for the desktop, and which for some reason defaults to C on occasions. I can help with LibreOffice theming, too. Sadly, the 6.0 release came just too late to include the new Qt5 VCL, so Qt4 is the next best thing for Plasma users. The trick is to enable the Breeze Qt4 theme, which you can set by running qtconfig-qt4 .

Jonni Bidwell

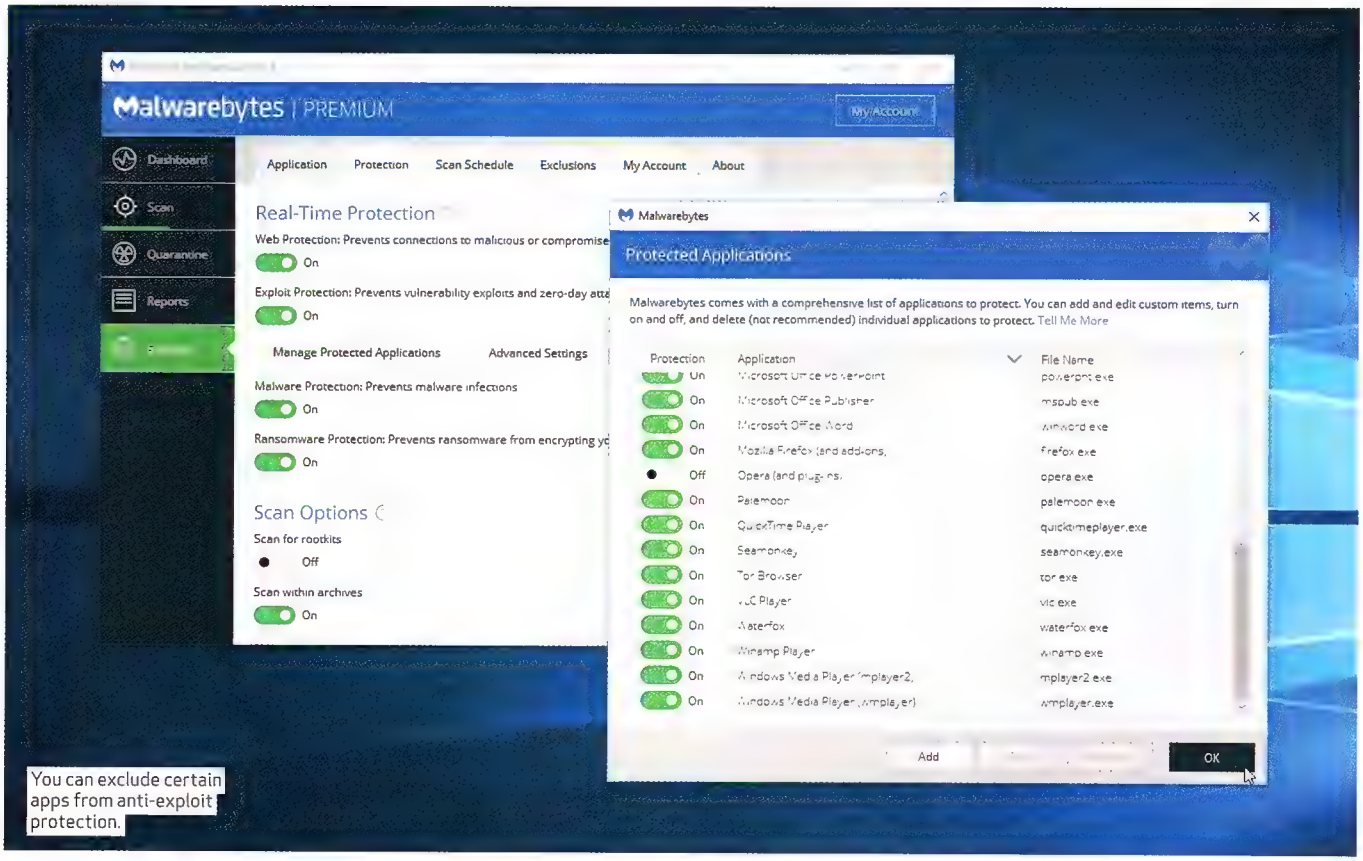
HARDWARE

HOT CHIPS

A few years ago, I built a PC with an AMD FX-8370, Sapphire's Radeon R9 390X, a 620W Antec HCG PSU and an ASUS M5A99FX Pro R2.0 shoved into a Thermaltake Urban S31 case. I recently started playing games more seriously, so I purchased an NZXT Kraken X31 120mm AIO cooler to alleviate the extra thermal load. I have a 120mm fan drawing air in through the radiator through the rear, another 120mm intake fan in the front, and a 240mm output fan on top. However, I am still seeing temps of up to 80°C under load, as recorded by HWiNFO. Is that normal for an FX-8370 at stock?

Liam Andrews

Temperatures that high on an FX CPU are highly unusual indeed. To start, are you certain those readings are correct? Try installing AMD's own OverDrive utility, keeping an eye on clock rates



You can exclude certain apps from anti-exploit protection.

and thermal margin readings. If the processor really is getting as hot as 80°C, the available thermal margin will be consumed (plus some), and you should see the chip throttle itself to avoid damage.

In that case, it's entirely possible that your closed-loop cooler isn't installed correctly. Check its thermal paste, the mounting hardware, and any attached fans to make sure they're spinning. Go into the motherboard's BIOS and make sure voltages are set correctly.
APC Team

INTERNET
GREY SCREEN IN WEB BROWSER

Every time I launch Opera, it opens to a grey screen. And if I open Chrome, I get the same grey screen plus a list of messages about add-ons crashing on startup. I can't access settings, extensions or find any way to relaunch either with extensions disabled. What can I do?
Bill Graham

We traced Bill's problem to the Chromium sandbox, which is present in both Chrome and Opera. Pressing 'Win-R' and typing "chrome -no-sandbox" or "opera -no-sandbox" enabled us to launch a working version of either browser (Chrome warned us about the flag we'd invoked, while Opera simply functioned as normal).

Most sandbox-related problems are often traced back to security software. Bill was running Norton Internet Security and Malwarebytes Premium.

A closed-loop liquid cooler should be capable of taming a stock FX-8370 CPU's 125W TDP.

We instructed him to temporarily disable Norton's auto-protect feature, to no effect, but after he'd disabled all four layers of Malwarebyte's real-time protection, Bill's browser problem disappeared. He then re-enabled them one at a time, and the problem resurfaced only when Malwarebytes' Exploit Protection module was switched back on.

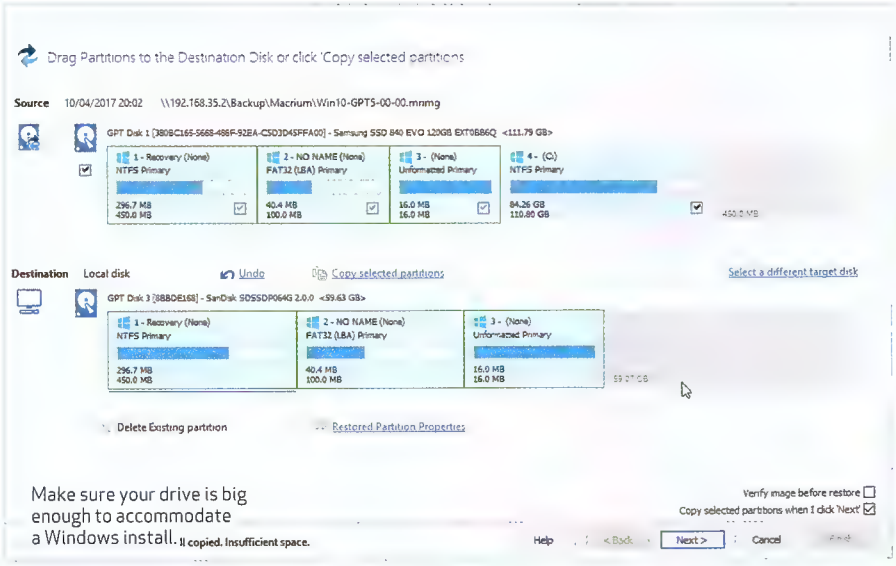
We checked the Malwarebytes forums (**forums.malwarebytes.com**) where a number of other users reported the same problem. This is likely to be resolved in a future fix, but for a temporary workaround, switch Exploit Protection back on under 'Settings > Protection', then click 'Manage Protected Applications' to disable Exploit Protection for both Opera and Chrome, both of which should be listed. This will allow you to run them with the sandboxing features enabled.
Nick Peers

HARDWARE
MIGRATING TO A NEW SOLID-STATE DRIVE

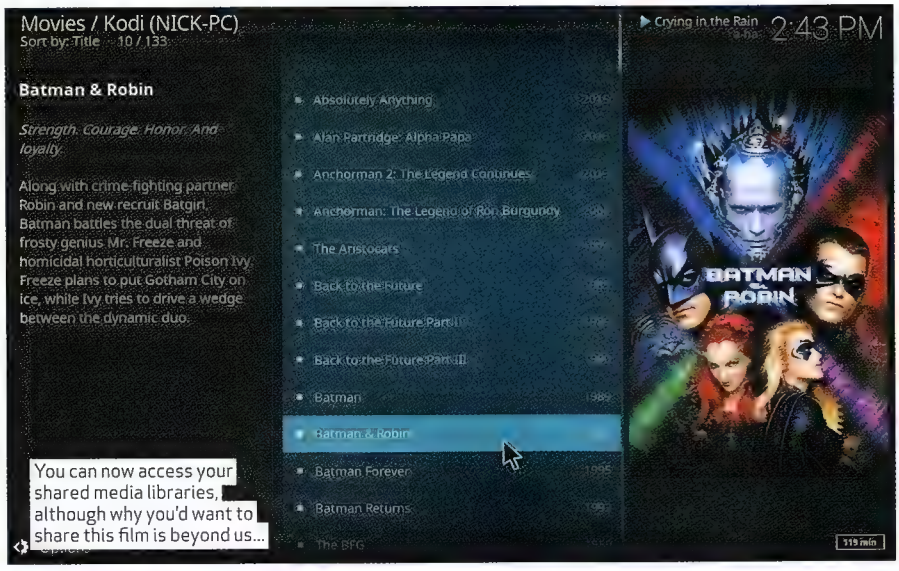
I'm planning to buy a solid-state drive and want to know if I can migrate my existing Windows system drive to the new drive using Macrium Reflect Free in conjunction with a rescue disc. I'm thinking of imaging the Windows system drive to DVD.
Peter Claxton

While it's possible to do what you want using DVDs, we don't recommend it, Peter. The size of your Windows system drive means a minimum of four discs – and probably many more – will be required. Furthermore, it's a slow process and you'll need to be on hand to swap out the discs. Instead, back up to an external hard drive or large (64GB or 128GB) flash drive following the guide at **www.techradar.com/1319885**

Once backed up and verified, swap out your old hard drive for your new one. Then boot from the Macrium rescue media and choose the Restore option. If your image isn't detected, click 'Browse for an image file' to manually select it. When you come to restore the image, Macrium should



Make sure your drive is big enough to accommodate a Windows install.


Movies / Kodi (NICK-PC)
Sort by: Title · 10 / 133
Batman & Robin
Strength. Courage. Honor. And loyalty.
Along with crime-fighting partner Robin and new recruit Batgirl, Batman battles the dual threat of frosty genius Mr. Freeze and homicidal horticulturalist Poison Ivy. Freeze plans to put Gotham City on ice, while Ivy tries to drive a wedge between the dynamic duo.
Absolutely Anything
Alan Partridge: Alpha Papa
Anchorman 2: The Legend Continues
Anchorman: The Legend of Ron Burgundy
The Aristocats
Back to the Future
Back to the Future Part II
Back to the Future Part III
Batman
Batman & Robin
Batman Forever
Batman Returns
The BFG
Crying in the Rain
2:43 PM
BATMAN & ROBIN
119 min

You can now access your shared media libraries, although why you'd want to share this film is beyond us...

> "Good as it is, Kodi simply doesn't provide as slick a user experience as Plex or Emby, but its DLNA-compatible server is widely accessible from a range of other devices."

detect that your new SSD drive is probably smaller than your old hard drive and offer to resize the partitions during the restore process.

Some further considerations: make sure that your SSD drive is large enough to comfortably accommodate your current C Drive, and be sure to choose the option to image all the partitions required to back up and restore Windows.

We usually recommend you hive off your data to a separate drive when upgrading to an SSD to give Windows room to breathe.

Nick Odantzis

MEDIA

SHARE YOUR KODI MEDIA LIBRARIES

I enjoyed your Kodi tutorial from issue 443 (page 88), but I'd like to be able to share my media directly from Kodi without having to use another program such as Plex. What must I do?

Gerry Bukowski

Good as it is, Kodi simply doesn't provide as slick a user experience as Plex or Emby, but its DLNA-compatible server is widely accessible from a range of other devices. Here's how you set it up...

1 **Switch on server:** Open Kodi and click the Settings button followed by Service Settings. Select UPnP/DLNA in the left navigation pane, then flick the 'Share my libraries' switch to On to share your media. Kodi should show up as a DLNA/UPNP source on compatible devices.

2 **Access your media:** You can access your shared media libraries from another computer, iPhone or Android device by installing Kodi on there. Once done, navigate to 'Service Settings › UPnP/DLNA' on there and flick the 'Allow remote control via UPnP' to gain access.

3 **Add content:** Next, you need to physically add the shared content to your client device – from the home page, select your target library and enter the files section. Click 'Add videos...' followed by Browse, UPnP devices and select your PC. Click OK twice.

4 **Consume media:** You can now access your shared media libraries – they won't show up on the main screen, instead, select Movies and click 'Enter files section' to manually browse your libraries using the same navigation tools as found in Kodi itself.

Nick Peers

LINUX

INVISIBLE ARCH

My machine is able to dual-boot into Arch and Ubuntu 16.04 LTS, which I won't be upgrading right now, based on the following experience... Whenever there's an Ubuntu kernel update, it updates both the GRUB and the boot menu, and this process takes inordinately long (in one case, I waited 10 long minutes and finally ended up manually killing the os-prober process, which seemed to be stuck using 100% resources).

I really don't need Arch entries on my Ubuntu GRUB, since I can (and prefer to) choose Arch from the UEFI menu. Can you tell me if it's possible to persuade Ubuntu not to interrogate my other partitions and save some time here?

John T

This bothered me for some time, and I eventually found an answer in the GRUB page of the ArchWiki. The solution given there is to install the `lsb-release` package on Arch, which makes os-prober's life easier. It adds some files which help to identify Arch. If you really want Ubuntu to not look for other OSes, then you could remove or comment out the contents of the /etc/grub.d/30_os-prober file, but since this will be replaced (or you'll be prompted to replace it) whenever a new GRUB package is available, this is probably not ideal.

Jonni Bidwell

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10 ways to speed up Windows 10

No one likes a slow computer, but there are plenty of tricks to give even the oldest machines a speed boost.

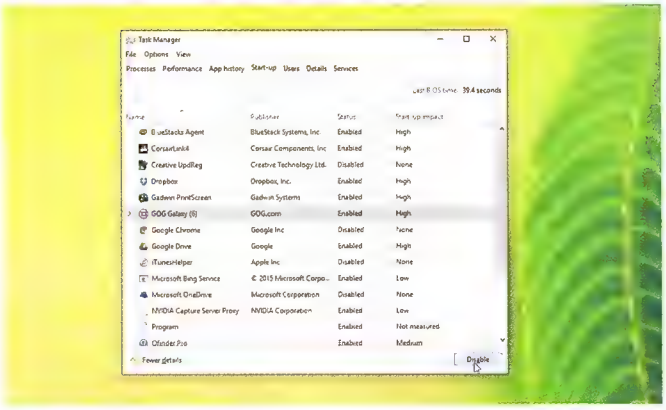
Unfortunately, as our computers age, the slower they become. A machine that used to spring into life and load up Windows in a flash may now chug along, taking its sweet time to display your desktop, making you wait even longer before you can actually use the device. This can be particularly annoying, and is usually caused by filling up your computer with ever more demanding software.

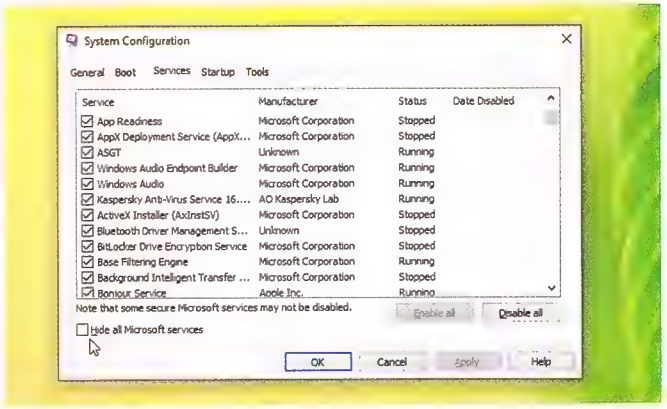
The good news is that, because these problems are usually software-based, it means you don't need to shell out for new hardware just yet. Instead, by giving your PC a spring clean and removing any software you don't need, and making sure Windows is up-to-date, virus-free and with the latest drivers installed, you're able to give your machine a noticeable speed boost without having to spend a cent!

In this guide, we'll take you through some of the best tips and tricks for speeding up a slow PC.

For a more comprehensive speed boost, a Windows reinstall may be needed. (Check out our feature in APC #452, page 70, on how to streamline your install to your needs.)

Speed up a slow computer



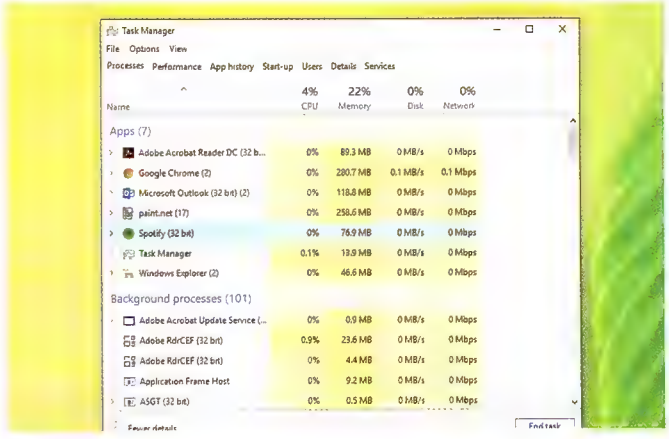


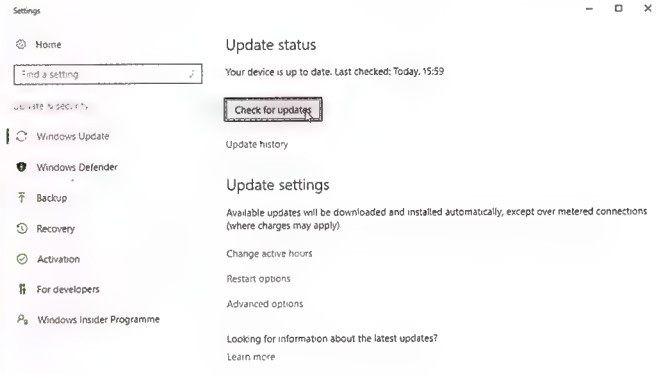
1 CUT DOWN ON START-UP PROGRAMS

Many apps you install will start themselves when Windows loads without asking you, and after a while, this means Windows is loading a lot of apps when it boots, which can slow down your PC. Cut these down by opening the Task Manager — press Ctrl-Shift-Esc — and click 'Start-up'. Click on the program you want to stop loading when Windows starts, then select Disable.

2 USE SYSTEM CONFIGURATION TO STOP SERVICES

The advanced System Configuration tool gives you the ability to disable services that start up with Windows. While some are needed for certain applications, having too many running can slow down your PC. In the Start menu, type in `msconfig` . Click the Services tab and check the box saying 'Hide all Microsoft services'. Now disable services connected to programs you rarely use.



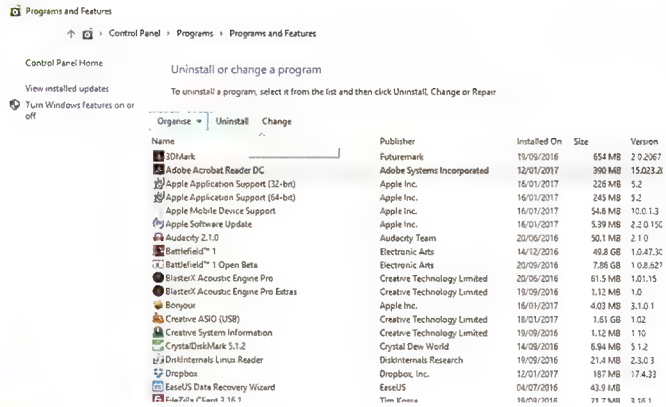


3 IDENTIFY RESOURCE-HUNGRY PROGRAMS

Certain programs use a lot of resources, which in turn slow your PC. Open the Task Manager again, then in the Processes tab, you'll see which programs and services are open, and how many resources they are using. If there are any programs that are taking up a lot of resources, close them (by clicking 'End task') for a speed boost, or uninstall them for something more permanent.

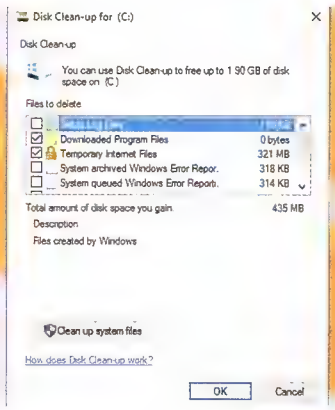
4 MAKE SURE WINDOWS IS UP TO DATE

Microsoft regularly releases updates for Windows which can fix bugs and problems that could cause your PC to run slowly, so it's a good idea to make sure you're up to date. In the Start menu, type `windows update` and press Enter. Click 'Check for updates' and if you're not using the most recent version, you'll be told. This won't increase speed, but it will keep your PC healthy.



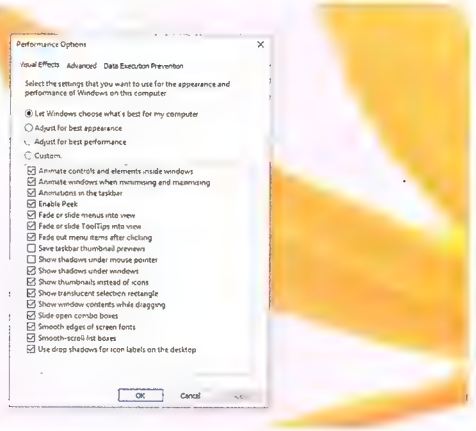
5 REMOVE UNUSED PROGRAMS

A PC with a clean and uncluttered drive will perform faster. Type `uninstall` in the Start menu and press Enter. Take a look through the list of installed programs and if there are any you no longer use, select them, then click Uninstall. If there are programs that you still use, it may be worth looking online to see if they have been updated, making them perform faster.


Disk Clean-up for (C:)
Disk Clean-up
You can use Disk Clean-up to free up to 1 90 GB of disk space on (C:)
Files to delete
Downloaded Program Files 0 bytes
Temporary Internet Files 321 MB
System archived Windows Error Repor. 318 KB
System queued Windows Error Report. 314 KB
Total amount of disk space you gain 435 MB
Description
Files created by Windows
Clean up system files
How does Disk Clean-up work?
OK
Cancel

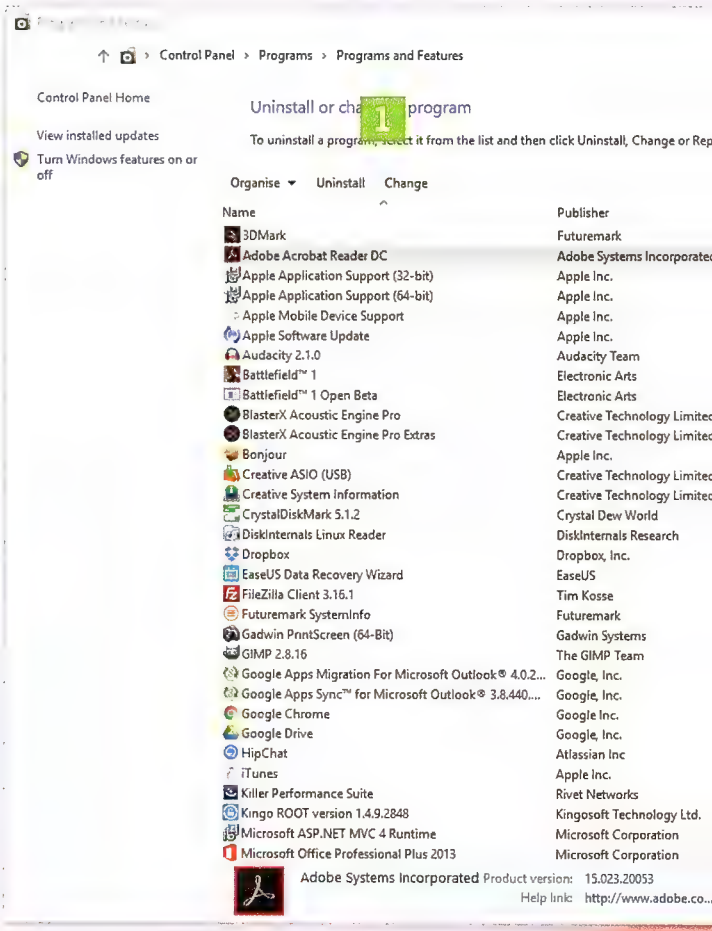
6 CLEAN UP YOUR DRIVE

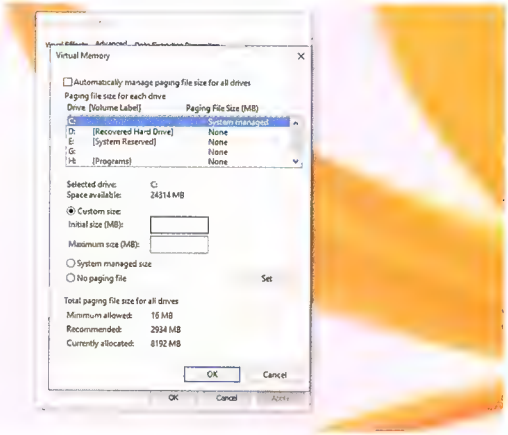
Next, use Windows' built-in Disk Clean-up tool. In the Start menu type `disk clean-up` then hit Enter. You'll be asked to choose the drive to clean up. For the biggest speed increase, select the drive which has Windows installed (usually C), and click OK. Disk Clean-up will scan your PC's drive and show you a list of suggested files to delete. Select the ones you want, then click OK.


Performance Options
Visual Effects
Advanced
Data Execution Prevention
Select the settings that you want to use for the appearance and performance of Windows on this computer
Let Windows choose what's best for my computer
Adjust for best appearance
Adjust for best performance
Custom:
OK
Cancel

7 REDUCE VISUAL EFFECTS

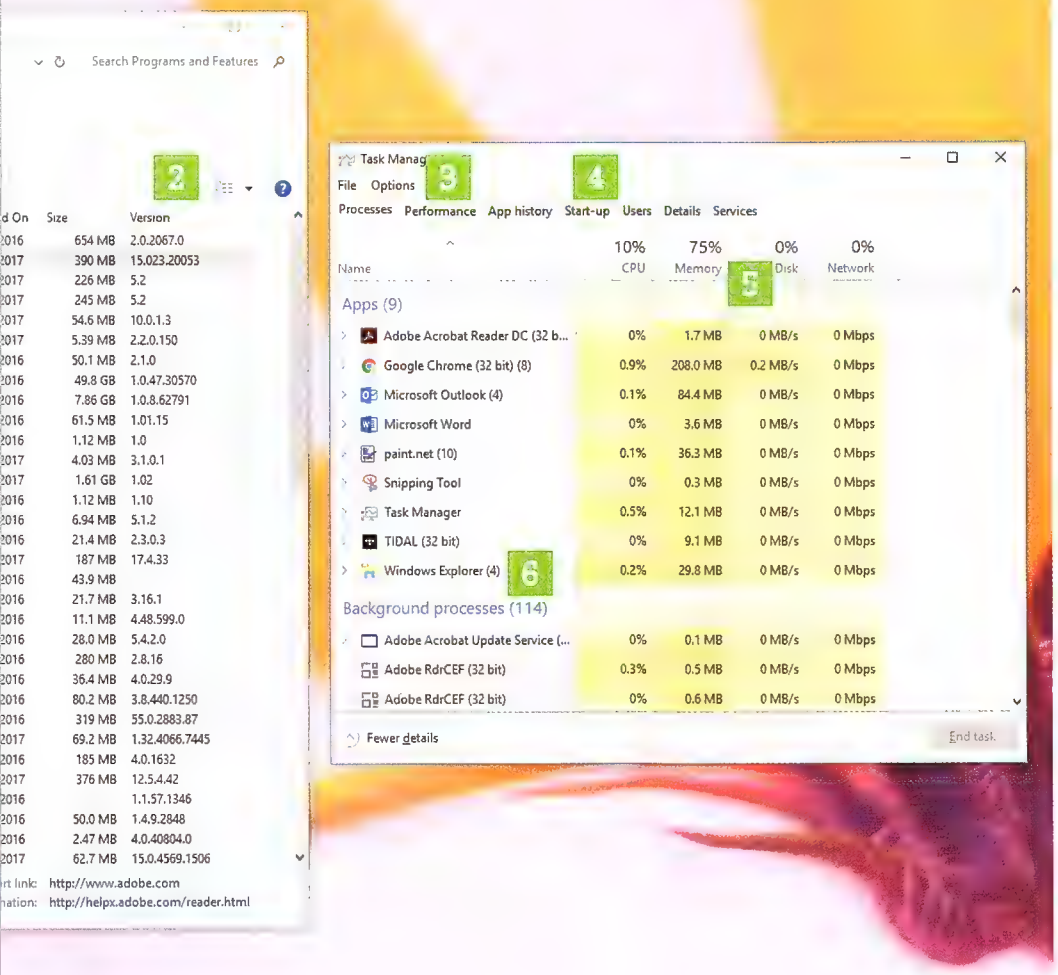
Each version of Windows looks better than the last, but its visual effects and animations can slow you down. To turn them off, open the Start menu and click Settings. Type `performance` in the text box, then click 'Adjust the appearance and performance of Windows'. The Performance Options window opens and, from there, either select 'Adjust for best performance' or Custom.





8 ADD VIRTUAL MEMORY

Speed up your PC by adding Virtual Memory, giving it a RAM boost. From the Performance Options window of the last step, click the Advanced tab, then the 'Change...' button. Uncheck 'Automatically manage paging file size for all drives'. Select your drive, then select Custom Size and set the Initial Size to the recommended amount and the maximum size to a higher figure.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Google Chrome (32 bit) (8) 0.9% 208.0 MB 0.2 MB/s 0 Mbps
Microsoft Outlook (4) 0.1% 84.4 MB 0 MB/s 0 Mbps
Microsoft Word 0% 3.6 MB 0 MB/s 0 Mbps
paint.net (10) 0.1% 36.3 MB 0 MB/s 0 Mbps
Snipping Tool 0% 0.3 MB 0 MB/s 0 Mbps
Task Manager 0.5% 12.1 MB 0 MB/s 0 Mbps
TIDAL (32 bit) 0% 9.1 MB 0 MB/s 0 Mbps
Windows Explorer (4) 0.2% 29.8 MB 0 MB/s 0 Mbps
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Background processes (114)
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Adobe RdrCEF (32 bit) 0% 0.6 MB 0 MB/s 0 Mbps
Fewer details
End task

1 UNINSTALL APPS
Keeping your drive free from unused programs can help your PC run faster. In the 'Uninstall or change a program' window, select a program that you don't use and then click Uninstall.

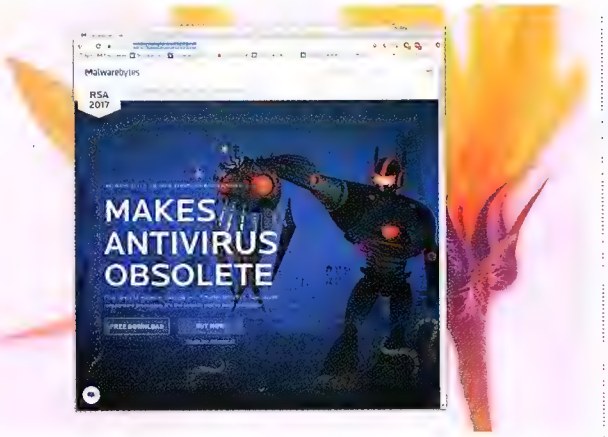
2 UPDATE PROGRAMS
Outdated apps may run slowly, so check this column to see which version you have installed. A quick internet search will tell you if a later version is available.

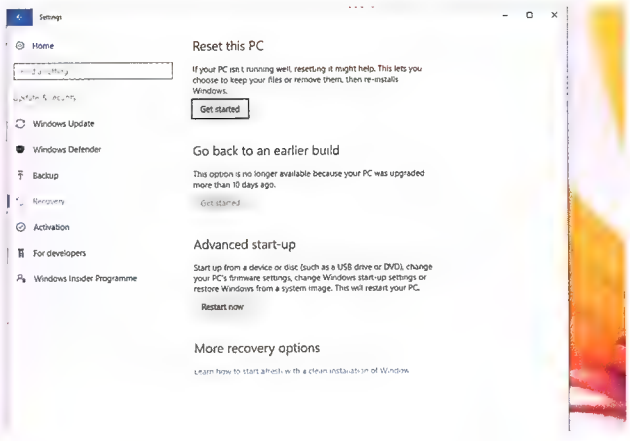
3 PERFORMANCE
Click here to see a graph of your PC's performance and the resources that are being used. Any large spikes mean an app is causing your PC to slow down.

4 START-UP
This shows which programs are loaded when Windows starts. Cutting these down will make your PC run faster and slash the number of processes that run.

5 RESOURCES
This shows you which apps and services are running, and how much of your PC's resources they are taking up. Close any resource hogs to speed up your PC.

6 BACKGROUND PROCESSES
The more apps that you install, the more processes they run. And too many can slow your PC. Check here to see if you can close any.





9 SCAN FOR VIRUSES
A slow PC could be symptomatic of a virus, so make sure you scan it — and remove any infected files — regularly. Windows Defender, which comes with every version of Windows since Windows 8, does a good job. Free alternatives include AVG (**www.avg.com**) and Malwarebytes (**www.malwarebytes.com**). Removing viruses will speed up our PC and protect your privacy!

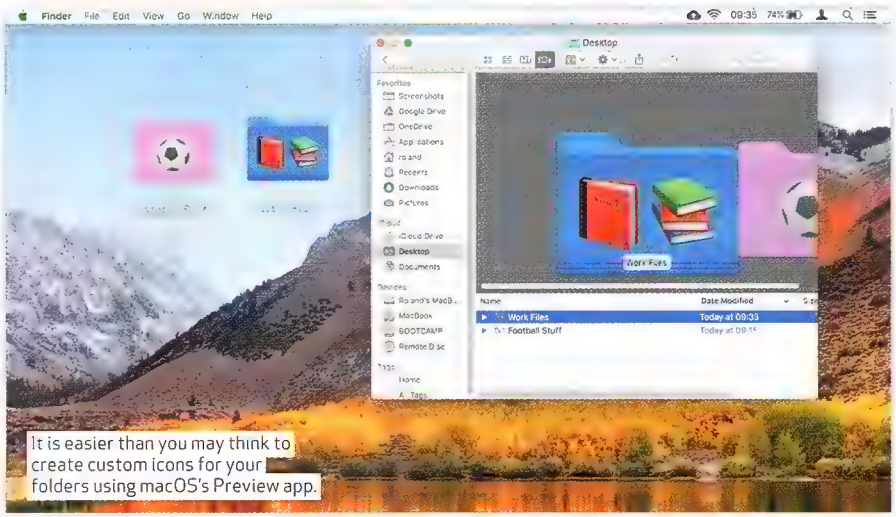
10 ADVANCED MEASURES
Your PC should now be running fast again. If not, it's time for advanced measures. First, clean up your registry with CCleaner (**www.piriform.com/ccleaner**), which will remove invalid and outdated Windows Registry entries, as well as leftover files from uninstalled apps. If that doesn't help, try reinstalling or refreshing Windows. No dice? Then it's time to upgrade your hardware.

Customise folders in macOS's Finder

Turn ordinary folders into special ones and make them stand out with colour, text and emoji.

Every folder on the Mac looks like every other folder. Don't you wish folders could be customised with your own designs? They can! It is actually quite easy to replace the boring blue folder icons with alternative ones and it takes just a couple of minutes with the Preview app.

Folders could be coloured to make special ones stand out in Finder windows or on the desktop. Some text on the folders would be useful and it could describe the contents. Folders that contain fun stuff like photos, music and other items could have fun designs like emoji characters. You will not want to do it to every folder, but it is great to do it with a few special ones.



It is easier than you may think to create custom icons for your folders using macOS's Preview app.

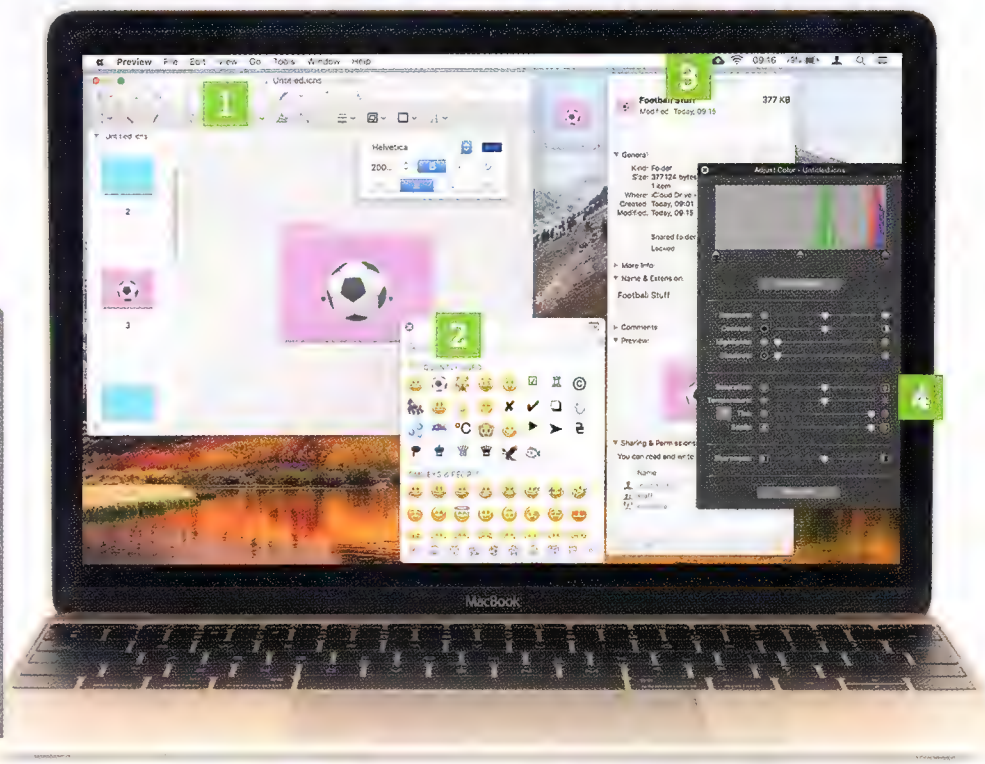
Create fun folders

Design your own folders with Preview.

Knowledge base

Restore customised folders.

After a folder has been customised and the icon replaced with a new design, you might wonder how to go back to the original. Is it possible to restore the default? You could create a new folder and copy the contents of the customised one to it. Better still, select the folder, press 'Cmd-I', click the icon and press 'Cmd-X'.



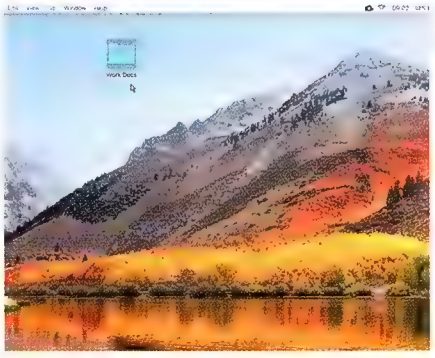
1 DRAW ON FOLDERS
Show Preview's markup toolbar and you can begin customising the folder design. Add shapes like lines, circles, rectangles and stars by clicking this icon and then size and colour them.

2 ADD EMOJI
Wherever you can type text, you can insert emoji. Click the T in the markup toolbar and then press 'Ctrl-Cmd-spacebar' to open the emoji window. Double-click one to insert it.

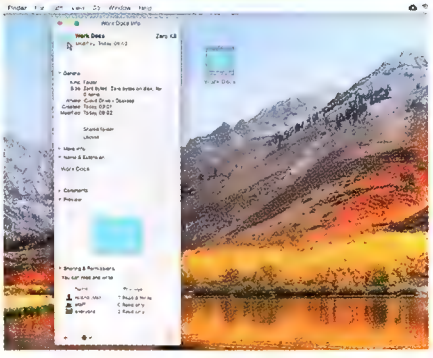
3 FOLDER ICON
Select a folder in Finder or the desktop and press 'Cmd-I' to open this window. Click this icon and press 'Cmd-C' to copy the image or press 'Cmd-V' to paste a new icon image.

4 COLOUR FOLDERS
If you fancy a change of colour, open the 'Adjust Colour' panel in Preview and drag the sliders to change the colour. It is best to simply experiment and see what happens with each of them.

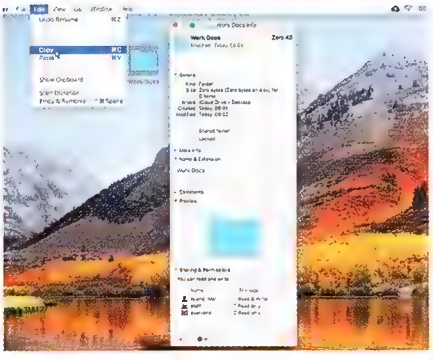
Create your own custom designs



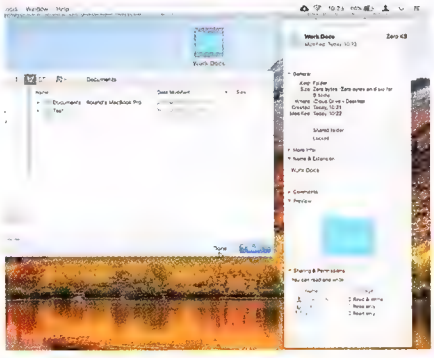
1 CREATE A FOLDER
Any folder can be customised but before changing anything important, try it with a test folder to get the hang of it. Create a new folder on the desktop from the File menu.



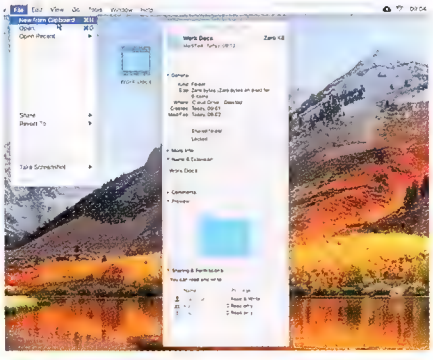
2 SHOW FOLDER INFO
Select the folder that you want to customise by clicking once and then go to the File menu and select 'Get Info'. It shows an icon at the top and larger preview lower down.



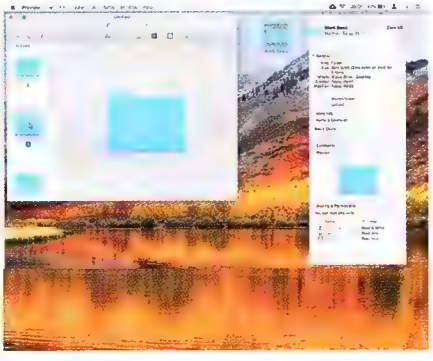
3 COPY THE ICON
Click the icon at the top of the Info window and either go to the Edit menu and select Copy or use the keyboard shortcut 'Cmd-C'. This copies the icon to the clipboard.



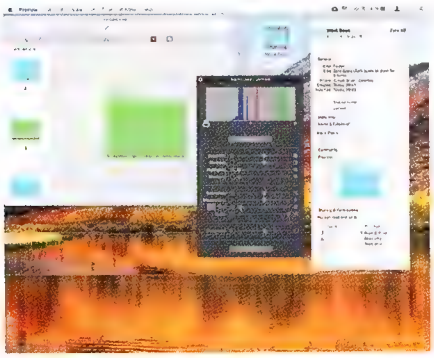
4 OPEN PREVIEW
Now that we have the folder icon, it can be edited in a photo editor and Preview is actually a great app for this. Open Preview and press Esc when the Open window appears.



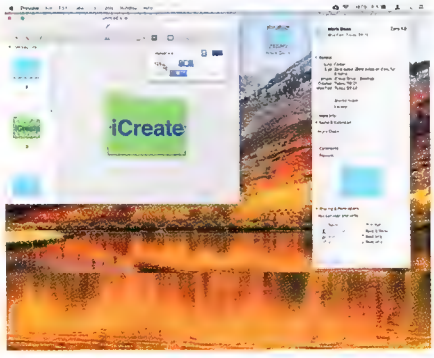
5 GRAB THE CLIPBOARD
The folder icon is on the macOS clipboard, so go to the File menu in Preview and select 'New From Clipboard'. This creates a new image and Preview opens it for editing.



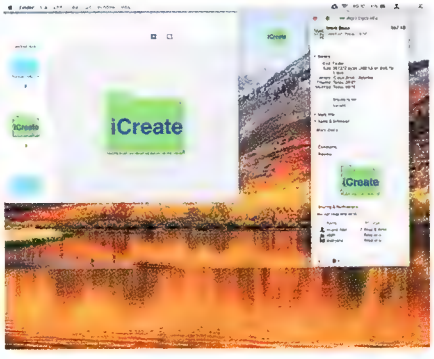
6 PICK AN ICON
Icons for apps, files and folders are not single images, but a collection of images at different sizes from very small to very large. Select a medium size icon, such as 3.



7 CHANGE THE COLOUR
Go to the Tools menu in Preview and select 'Adjust Colour' to open the colour panel. Use the slider like Tint, Sepia and Temperature to change the colour of the folder icon.



8 ADD TEXT
Go to the View menu in Preview and select 'Show Markup Toolbar'. Any of the tools can be used to modify the folder icon. For example, click the T tool and then add text.



9 COPY YOUR DESIGN
When you are happy with the design of the folder, click the folder to select it and press 'Cmd-C' to copy it. Click the icon at the top of the Info window and press 'Cmd-V' to paste. And there you have it!

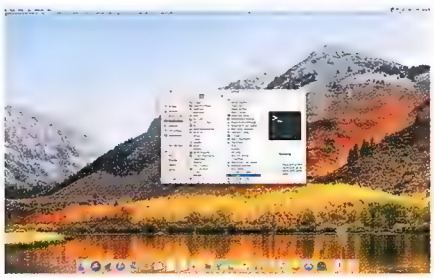
Play hidden games in the macOS Terminal

Take a break from work with a cool selection of classic titles already available to play.

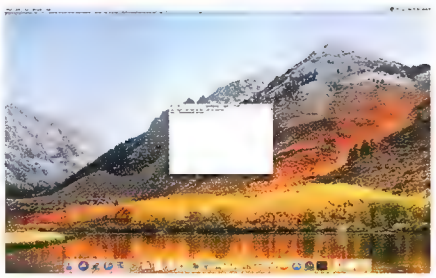
There comes a time, during a stressful working day, when you just want to kick back and have a bit of fun. So what better way of doing this than firing up a fun game from yesteryear on your Mac? You may not know that you already have many titles at your fingertips thanks to Terminal. From Tetris to Pong and from Solitaire to Snake, you're bound to love the nostalgia and instant pick-up-and-play experiences they provide. Here, we look at how you can not only access these free games but discover what you actually have to play. One of our favourites is the text adventure *Dunnet* – mainly because its interface makes it look like you're working, when you're actually typing commands such as 'take shovel' to see what happens next.

Playing retro games is just one of Terminal's many uses and it is an app that is well worth exploring...

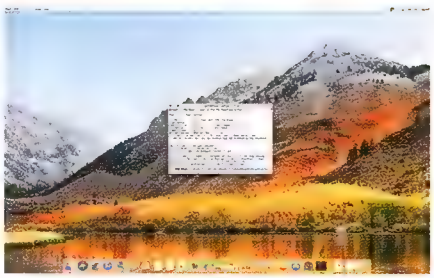
Launch classic games using Terminal



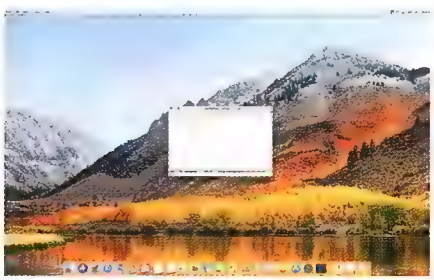
1 OPEN TERMINAL
Launch Terminal on your Mac. You will be able to locate this by opening a Finder window, selecting Applications from the left-hand column and clicking the Utilities folder.



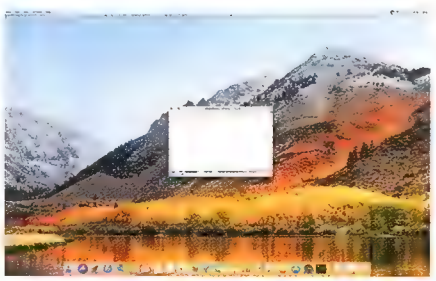
2 ENABLE EMACS
Built into your Mac is a family of text editors called Emacs and it must be launched in order to get our games working. Just type "emacs" into Terminal and press Enter.



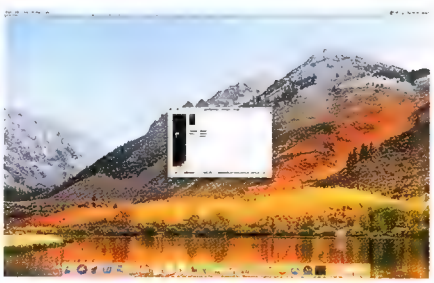
3 PRESS ESCAPE
The screen will fill with text but simply look out for the highlighted words 'GNU Emacs' at the bottom of the window. Once you see this, press Esc on your keyboard.



4 HIT THE 'X'
Now, all you need to do is press the X key on your keyboard so that the prompt at the bottom of this window reads 'M-x'. It is now ready for you to input the name of a game.



5 TYPE A NAME
It is now time to choose the game that you wish to play. Look at the boxout opposite to see how you can discover the games you have. In our case, we're typing "tetris".



6 PLAY THE GAME
The game will now appear on the screen in all of its retro glory, ready for you to start playing. For many of them, you can use the cursor keys and spacebar to play. Enjoy.

Play the games

Kick back and enjoy some great retro gaming classics for free.

Knowledge base

Text-based games.

As well as arcade classics, you can also enjoy some text-based games that need you to type commands. Aside from text adventures such as *Dunnet*, there is even a therapy session of sorts. Type "doctor" when inputting a game name and you'll be welcomed by a psychotherapist. You can then have a conversation. Will it diagnose you (or even fool you into thinking it's real)?

1 QUITTING A GAME
To leave a game, you must press Esc and X. This allows you to type the name of another game. You can also quit emacs on Terminal by holding the Ctrl key and pressing X, then C.

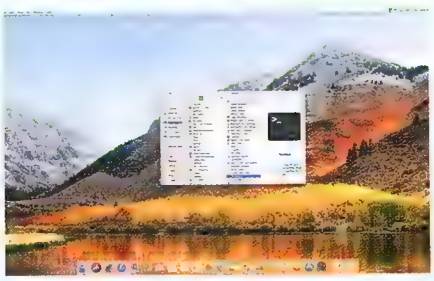
2 KEEPING SCORE
Many of the arcade games let you keep score and this is displayed on the screen, usually just outside of the playing area itself.

3 SMALL SCREEN GAMING
What these versions of age-old classics lack in size and graphical prowess, they make up for with immediate, addictive gameplay such as with Pong which dates back to 1972.

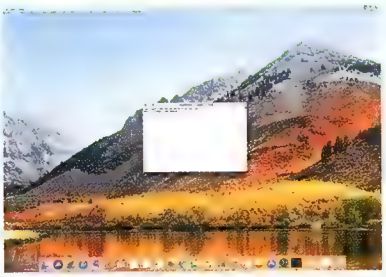
4 GOOD CONTROLS
Depending on the game you are playing, typically you'll be using the cursor keys and/or the space bar to control what is happening on the screen.

Finding games to play

There are many simple games for you to play for free within Terminal, so you really ought to take a look at what is available on your computer. To do this, you simply need to delve into the appropriate folder and there are two ways of doing this: within Terminal itself or via a Finder window. Here, we look at both of those methods. You'll be surprised at what wonders lurk deep within your Terminal app ready to be unlocked and enjoyed time and time again.



1 LOOK VIA TERMINAL
Open Terminal from the Utilities folder on your Mac and immediately type: "ls /usr/share/emacs/22.1/lisp/play". A list of available games is now displayed so make a note of them.



2 VIEW VIA FINDER
Or open a Finder window and click Go. Select 'Go To Folder' and type "/usr/share/emacs/22.1/lisp/play". Click Go and the games files will appear, so you can note the names.

Learn to code Apple's Swift on your iPad

Want to learn to code by playing games? Carrie Marshall shows how to get on board, one Byte at a time.

Swift Playgrounds may be one of the most important apps Apple has ever made. Designed for coding newbies and distributed free to anybody who wants it – including educators – it's one of the most fun ways to learn the basics of coding. Once you know the basics, you can take that knowledge to any language, not just Swift. The app exports to Xcode but its lessons are universal.

Swift Playgrounds works by solving puzzles: here's your character, Byte, and here's what you need him to do. The app then takes you very carefully (but not too slowly) through the code you need to perform the action. So for example, you'd use moveForward() to make Byte take a step forward and collectGem() to pick up a gem.

So far so good. The app offers QuickType suggestions for effortless input, enables you to run your code and see if it works, and it also makes it easy to see where any mistakes have occurred and how to fix them. In no time at all, you'll be crafting complex strings of actions not just for Byte, but for augmented reality entertainment and even real-life drones, if you have them. The app works with Parrot drones, Lego Mindstorms EV3, Sphero robots and many, many more connected devices. It's learning by accident!

Swift Playgrounds feels a bit like iBooks, or Books as it's now known: each lesson is downloadable in what looks like the App Store or iTunes store and then stored in your library. But you can also add subscriptions from third parties. They aren't financial subscriptions but channels, so for example, you might subscribe to a Lego channel in order to control Mindstorms toys.

Swift Playgrounds is great fun for beginners and older souls alike: it feels like a game, not a grind, and it's deceptively powerful. It makes coding feel like the most fun thing in the world.

Swift Playgrounds' playground

1 LESSON CONTENTS
Tap on the bulleted list icon to see this. Lessons you've already completed appear with green ticks.

2 CURRENT LESSON
The lesson you're currently learning is indicated with a line and red text to make it stand out better.

3 MAIN WINDOW
This is where you'll learn what to do and what code you need to use in order to make things happen.

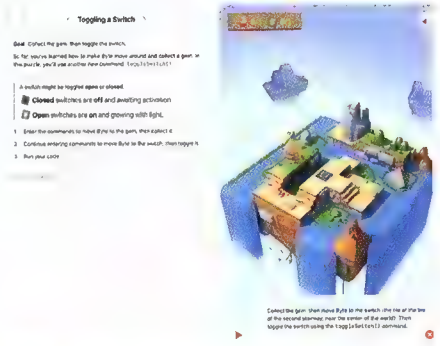
4 BYTE
Byte is the character used to introduce you to coding. Your code makes him perform actions in here.

How to:

Play in Swift Playgrounds

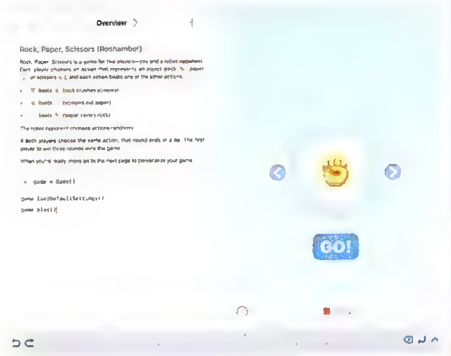
1 WELCOME ABOARD

Download Swift Playgrounds from the App Store and then use it to download Learn To Code 1. It works just like iTunes or Books. Launch the lesson and it'll provide a gentle welcome to the key ideas.



4 GET MORE ADVANCED

Things get interesting fast: one moment you're typing your first movement command, the next you've got Byte moving all over the place toggling switches. We think Apple has pitched this just right.

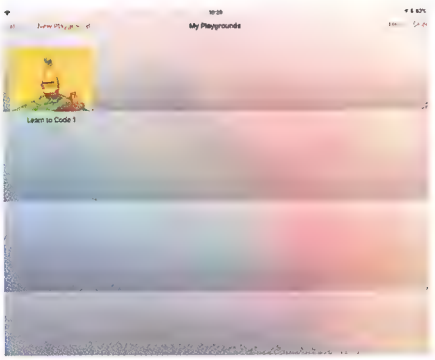


7 ROLL YOUR OWN

This Rock, Paper, Scissors game is simpler than Byte's adventures and again pitched for beginners. It's designed to get you digging into the customisation options in order to make the game your own.

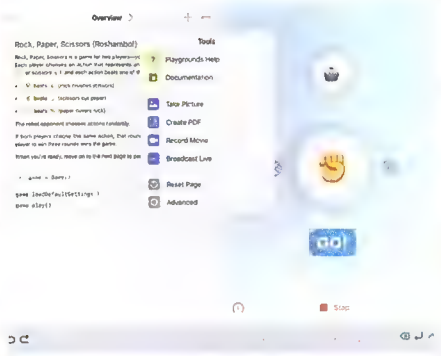
2 START PLAYING

We've come a long way from LISP and turtles, or even BigTrak: Swift Playgrounds enables you to control an in-game character called Byte. Here, we've been asked to give Byte move and collect commands.



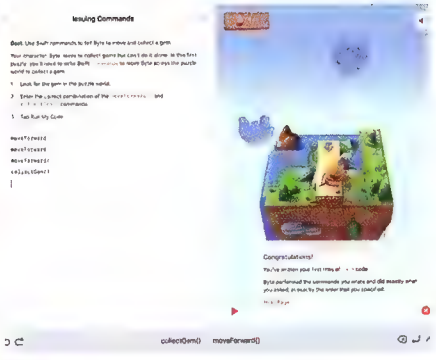
5 GET MORE EDUCATION

Tapping the icon in the very top left-hand corner takes you back to your library, which is going to look just as sparse as ours does here. To access another lesson, tap on the New Playground link.



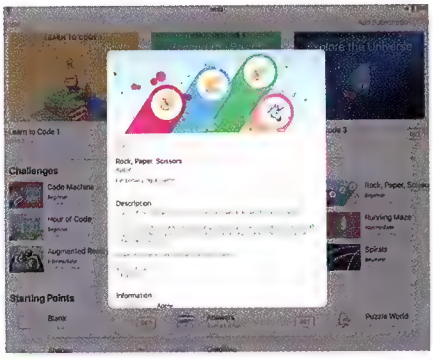
8 SHARE YOUR STUFF

If you tap on the triple-dot icon, you'll see some cool features below the help options. Swift is designed for sharing: you can grab an image, record a movie or even broadcast live to adoring crowds.



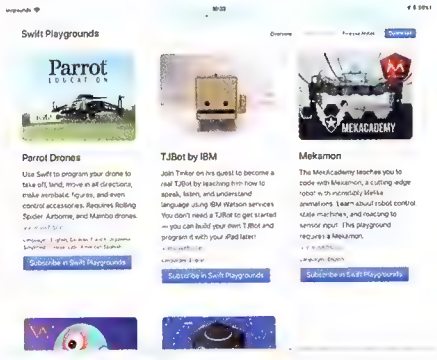
3 RUN THE CODE

When you run the code, Byte will do as he's told, and if you've got it right, you'll be congratulated with an explanation of what you've achieved. If not, you'll be guided gently to the correct solution.



6 GET MORE GAMES

Lessons cover a really good range from Rock, Paper, Scissors [*Scissors, Paper, Rock, grr — Sub-Ed*] for beginners, to mazes, and even using augmented reality to place cartoon characters in real-life rooms.

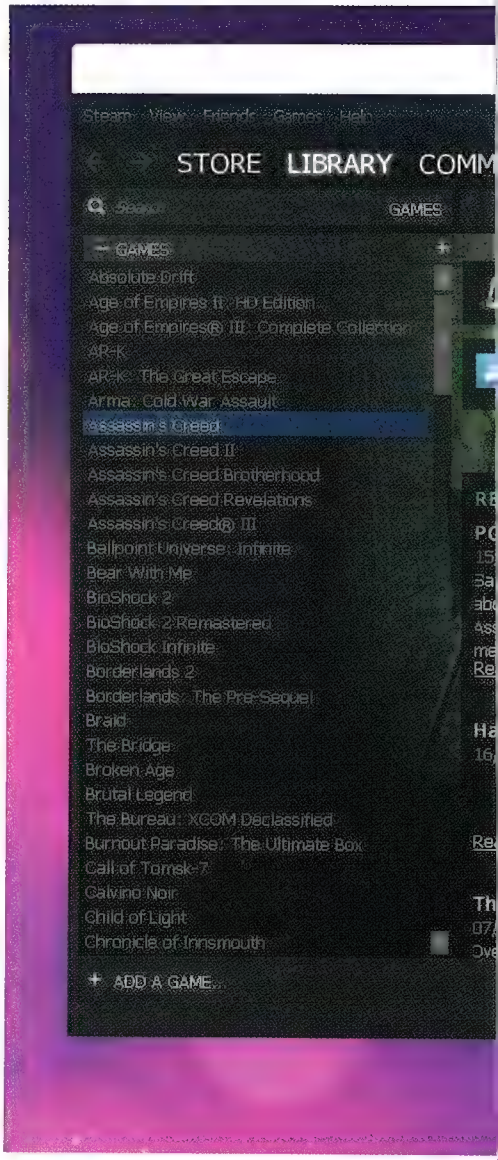


9 GET CONNECTED

When you're selecting lessons, tapping 'Add Subscription' enables you to connect Swift Playgrounds to third-party devices such as Lego, drones and bots. The possibilities are endless.

Run Windows apps on Linux with Wine

Jonni Bidwell can't afford to buy Central Otago Pinot Noirs, but Wine at least enables him to run programs from the other side.



Linux is a perfectly adequate replacement for Windows. In fact, for many tasks, it's arguably actually superior, in almost every way.

However, even we have to admit that sometimes, certain Linux users will have just-cause to run Windows applications. This might be because Karen from accounts has sent a Word document full of macros and tables and oddly named fonts that needs to be returned, along with accompanying TPS reports, by the end of the day. Some people want to play games not available on Linux, whether they're classics from that have long been abandoned, or triple-A releases that may never make it to the penguin side.

Many people have a dual-boot arrangement or a separate Windows machine altogether, but rebooting or moving to another room is a chore. Wine can also be useful helping people migrate to Linux, enabling them to use Windows tools until they get used to their Linux equivalents.

For nearly 25 years, Wine has made it possible for Linux users to run Windows programs from their OS of choice. The results weren't always pretty, but if you haven't checked it out for a while, you may be pleasantly surprised.

In the beginning, there were just a handful of coders working on the project, but today, hundreds of contributors (both volunteers and sponsored) contribute to this most unique of FLOSS projects. Its rapid fortnightly release cycle means that bugs are squashed quickly, but also that your distro might have trouble keeping up.

We'll show you how to get the latest versions, or even try out some extra patches. And we'll guide you through setting up DXVK, so you can leverage the power of Vulkan to play DirectX 11 games. Throughout history, wine has been used as a salve to heal one's worldly woes. Wine has also been linked with confusion, headaches and regrets. Its namesake in the free software world is in many ways similar: it enables Linux users to run Windows programs, but can lead the user to places they'd rather not be, and confront them with errors they'd rather not see.

Wine was formerly a recursive acronym for Wine Isn't aN Emulator, but that has fallen out of fashion. From far enough away, it certainly behaves like an emulator, though what it actually does is translate win32 API calls to Linux ones; there's no machine-level emulation involved. Once you've got it installed, you can – in theory – run a Windows program with a simple:

```
$ wine program.exe
```

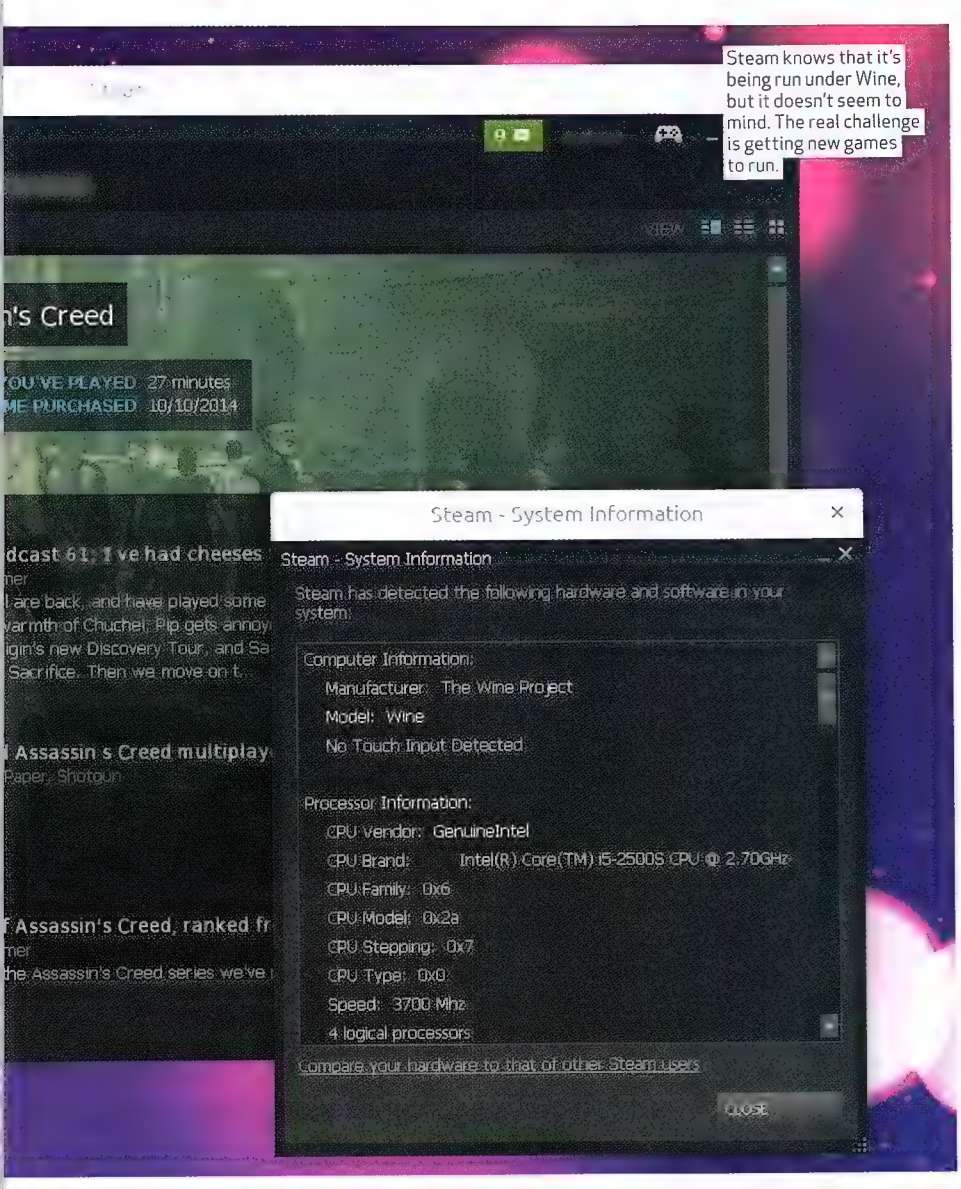
Before we hit the proverbial bottle, we should explain how Wine operates. Wine maintains its own virtual Windows install (called a Wine prefix or sometimes a Wine bottle, so the start of this paragraph was apt) in the ~/.wine directory. There's a virtual `drive_c/` subdirectory inside the Wine prefix replete with the familiar `Program Files/` and `windows/` directories, and interred in the latter, you'll find a bunch of .DLL libraries. These haven't been ripped from a Windows install (which would be a lawsuit waiting to happen); rather, these libraries have been reverse-engineered or coded based on API documentation to function as closely as possible to the Windows ones. This isn't an exact process, though, and some applications will need native Windows DLLs to function correctly.

Native DLLs can be manually copied from an existing Windows install to the `windows/system32` directory, though some require Registry keys and such to be set up (Wine actually stores its own settings, as well as Windows ones in databases that can be viewed with its own RegEdit). Most programs will install all the DLLs they need automatically, and installers are generally available for those that don't. Animals like the Visual C runtimes, for example, are best installed by running (with Wine) the installers available from Microsoft's website. This process can be automated with the popular Winetricks utility (see above left).

In the case where we want to use a native DLL that we have installed, as opposed to one of Wine's built-ins, we can use Winecfg, Wine's GUI configuration utility, or let Winetricks to it for us. Besides DLL marshalling, Winecfg can manage lots of other things (including audio, graphics and virtual drives) from the comfort of a Windows-like dialog. You can also choose which Windows version to imitate from here. By default, the root filesystem is mapped to a virtual Windows drive Z: so any program you run with Wine can access anything that your user can. This means we need to take care what we run. A dodgy executable containing malware could encrypt, or even delete, anything our user has write access to. Even if you change the virtual drive settings, Wine doesn't provide anywhere near the same amount of isolation as a virtual machine, so it shouldn't be used for running anything of uncertain provenance.

SIPPING THE WINE

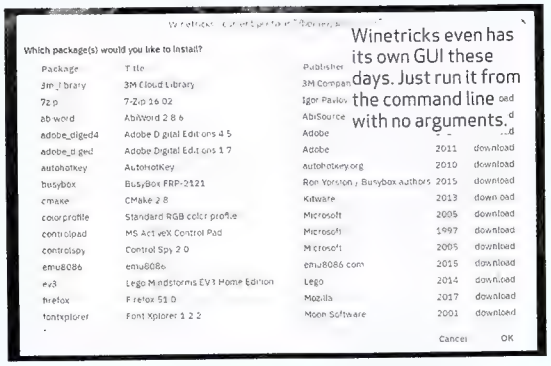
When you first run Wine, depending on your distro, it'll offer to install its own Mono and Gecko libraries. These are


Steam - System Information
Steam - System Information
Steam has detected the following hardware and software in your system:
Computer Information:
Manufacturer: The Wine Project
Model: Wine
No Touch Input Detected
Processor Information:
CPU Vendor: GenuineIntel
CPU Brand: Intel(R) Core(TM) i5-2500S CPU @ 2.70GHz
CPU Family: 0x6
CPU Model: 0x2a
CPU Stepping: 0x7
CPU Type: 0x0
Speed: 3700 Mhz
4 logical processors
Compare your hardware to that of other Steam users
CLOSE
Steam knows that it's being run under Wine, but it doesn't seem to mind. The real challenge is getting new games to run.

Installing Wine

If you're using Ubuntu 18.04, you'll find two versions of Wine in the Software application: the standard version and the development version. These refer to the packages `wine-stable` and `wine-development` if you'd rather install them with `apt install`. If you're using an older version of Ubuntu, these will be much older, but newer versions are available from the **winehq.org** PPA, and you'll find instructions for enabling it at **wiki.winehq.org/Download**. These packages provide three different branches: `winehq-stable`, `winehq-devel` and `winehq-staging` (in order of stability). The ever-so-handy Winetricks script is available in most repos, too, but users of Debian and older versions of Ubuntu may want to grab it directly from **github.com/Winetricks/winetricks**.

Wine has a rapid fortnightly development release cycle. It's worth noting that the WineHQ packages won't have enjoyed the same level of testing as distros' own packages, but such is the price of life on the edge.



Winetricks even has its own GUI these days. Just run it from the command line with no arguments.

used for running .NET applications and rendering HTML respectively. Ubuntu used to provide its own packages for these (called `wine-mono` and `wine-gecko` and other distros still do. If your distros provides these packages, you should use them, and if not, let Wine install them for you. Forgetting they're not installed can lead to some lengthy pursuits of wild geese.

By default, Wine sets up a 64-bit prefix, which is fine (Wine implements Windows' WoW64 subsystem) until you run into a 32-bit application that tries to install some other libraries. Said application will detect its 64-bit environment and duly install libraries with too many bits, which won't work. We hit this problem with the GoG Galaxy client (detailed at **bugs.winehq.org/show_bug.cgi?id=43095**). The solution is to use a 32-bit Wine prefix to install GoG, achieved by prefixing the `wine` command with `WINEARCH=win32`. We also ran into another problem with the latest version of GoG Galaxy. The solution there was to install an older version (get it from **cdn.gog.com/open/galaxy/client/setup_galaxy_1.2.17.9.exe**) and upgrade.

FUN ON WINE

Linux users have much less cause to whine about gaming than in days gone by. But one of Wine's major use cases is for playing games not available on Linux, so let's look at how we'd get Steam running on Wine using Winetricks.

It's just a straightforward matter of:

```
$ winetricks steam
```

Then to run it (things often don't work when you try and start them from the installer), we need to do:

```
$ cd ~/.wine/drive_c/Program\ Files\ \(x86\)/Steam/
$ wine Steam.exe -no-cef-sandbox
```

The last argument works around a long-standing bug that prevents the Store and other parts of the Steam interface from loading. Many games will work without further intervention, but the Wine AppDB (**appdb.winehq.org**) should be your first port of call if it all goes pear-shaped.

The cross-platform Vulkan graphics API may bring more exciting games to Linux sooner, or at least offer more efficient ports when they do arrive. Much of the work done by companies such as Aspyr Media and Feral is concerned with translating DirectX calls to OpenGL ones. They'd still have plenty to do if this step was replaced by tweaking Vulkan calls, but the workload would be significantly reduced. This depends on industry adoption, though (many publishers are favouring Microsoft's new DirectX 12

There's been a lot of demand for a Linux GOG Galaxy client. Hopefully, when it arrives, it won't suffer these sort of cosmetic ills.
GOG GALAXY
Select Destination Location
Where should GOG Galaxy be installed?
Setup will install GOG Galaxy into the following folder.
To continue, click Next. If you would like to select a different folder, click Brows
C: \Program Files (x86)\GOG Galaxy
Browse...
At least 408.8 MB of free disk space is required.
< Back
Next >
Cancel
PC World

runtime), and in general, it's a hard sell to get them to cater for a minute Linux audience.

Until that all changes, though, Wine can help gamers get their fix. For a long time, Wine could only translate DirectX 9 (and below) calls, but support for DX10 and 11 was added to mainline with the 3.0 release in January 2018. There are also a number of projects that aim to provide libraries allowing DirectX games to run over Vulkan. There's VK9 (**github.com/disks86/VK9**) for DirectX 9 calls. This project is still in its infancy, but will hopefully be a boon for fans of older titles.

GOD OF WINE

Then there's DXVK which does the same for DirectX 11 calls. This project is further along than the former, so let's give it a whirl. We'll use a separate Wine prefix to try it out, so that anything you've got in the default ~/.wine won't be upset. You'll need at least Wine 3.5 to be able to use DXVK (so the `wine-development` packages in Ubuntu 18.04 will be fine), and it should work with Wine Staging, too. You'll also need to have hardware that supports Vulkan, as well as drivers that support DXVK (see **github.com/doitsujin/dxvk/wiki/Driver-support** for updates).

Binaries are available from the project's GitHub (**github.com/doitsujin/dxvk**), you'll find them in the Releases section, so grab the latest tarball (0.50 at the time of writing) from there and set it up:

```
$ tar xvzf dxvk-0.50.tar.gz
$ cd dxvk-0.50/x32
$ WINEPREFIX=~/.winedxvk bash setup_dxvk.sh
$ cd ../x64
$ WINEPREFIX=~/.winedxvk bash setup_dxvk.sh
```

We also need the Vulkan SDK (actually just the ICD loader part of it, but it's easier to just install the whole shebang) to make use of this goodness. With a recent (more recent than the one currently in the Arch repos) version of Winetricks, this can be done with:

```
$ WINEPREFIX=~/.winedxvk winetricks vulkansdk
```

Otherwise we can run the installer, available at **vulkan.lunarg.com/sdk/home#windows** manually with

```
$ WINEPREFIX=~/.winedxvk wine VulkanSDK-1.1.73.0-Installer.exe
```

Next, we need to create a file in our Wine prefix that tells it about our Installable Client Driver (ICD). Create this with `nano ~/.winedxvk/windows/winevulkan.json` and populate it with the following code:

```
{
    "file_format_version": "1.0.0",
    "ICD": {
        "library_path": "c:\\windows\\system32\\winevulkan.dll",
        "api_version":
```

Wine worth paying for

CrossOver is a commercial version of Wine provided by CodeWeavers, available for macOS and Linux. There's also a beta version available for ChromeOS (for Intel Chromebooks only), which uses the Android subsystem. It has its own installer for Windows applications, replete with all the tweaks and DLL substitutions necessary to run them smoothly. Thanks to some proprietary additions, CrossOver boasts the ability to run things that standard Wine cannot, most notably Office 2016, but many games, too.

Besides this, CodeWeavers also performs extensive testing of popular applications on CrossOver, to ensure new software works and that new CrossOver releases don't introduce regressions. And the company provides technical support, too. Proceeds from CrossOver contribute to Wine development, and they pay many of the Wine developers' salaries. CodeWeavers also provides the infrastructure for **winehq.org**. So they're pretty much the opposite of so many other companies that profit from FLOSS products without giving anything back. This is one of those times where we don't mind proprietary software. You can download a fully featured 14-day free trial, and CrossOver Linux prices start at US$40 (for a single version). CodeWeavers does recommend testing your programs thoroughly in the trial version before you stump up any cash. It's a good product, but it's not perfect.

```
"1.0.51"
    }
}
```

Now we need to dip into the Registry and add some keys to sideload this file. Run `WINEPREFIX=~/.winedxvk regedit` . Then navigate to HKEY_LOCAL_MACHINE\SOFTWARE\Khronos\Vulkan create a new key called `Drivers` . Inside this key create a new DWORD (right-click in the right-hand panel) entitled `C:\Windows\winevulkan.json` and leave its value as 0. Create another `Drivers` key at HKEY_LOCAL_MACHINE\SOFTWARE\Wow6432Node\Khronos\Vulkan and once again create a `C:\Windows\winevulkan.json` DWORD with the value 0. Close Regedit and run the VulkanInfo tool with:

```
$ cd ~/.winedxvk/drive_c
$ WINEPREFIX=~/.winedxvk/wine ./Program\ Files\ \(x86\)/VulkanRT/1.0.68.0/vulkaninfo.exe
```

A newer Vulkan runtime may be available by the time you read this, in which case you'll need a higher number here. Also, daily builds of DXVK are available from **haagch.frickel.club/files/dxvk**. We ended up having to use these to get around a `d3d11.dll not found` error, but this will probably be fixed by the time you read this. You can use some ninja wgetting to grab all the files at once:

```
$ wget --recursive -np -R "index.html*" -nH -cut-dirs=3 https://haagch.frickel.club/files/dxvk/r1093.c7d2957/
```

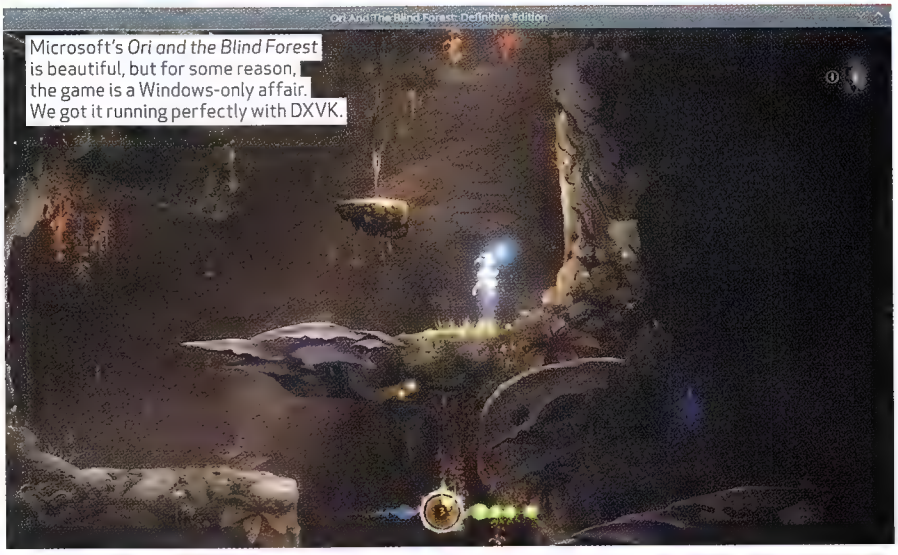
Then re-run the setup scripts, remembering the `WINEPREFIX` variable as above. If things go wrong the DLL-redirection can be turned of and things reset by appending `reset` to the scripts.

FINE WINE VINTAGES

Wine PBA, another patchset based on Wine Staging, has recently been made available by Andrew Comminos, an avid World of Warcraft (on Wine) player. Andrew's efforts are documented at **comminos.com/posts/2018-02-21-wined3d-profiling.html**. Ultimately, he discovered that, during gameplay, Wine's Direct3D 9 thread spent a fair amount of time awaiting work, but that this could be ameliorated through Persistent Buffer Allocation.

CodeWeavers has undertaken the ambitious task of creating a Direct3D 12 to Vulkan translation layer in the form of VKD3D. Although this is being coded by Wine developers, it's an independent project and so could be attractive to people porting games and other applications in the future. Some titles have already been ported using a pre-packaged Wine, but this approach isn't suitable for everyone. With VKD3D, some code can be rewritten to run natively, Direct 3D code can be translated and there's no need to bundle Wine and all its libraries.

Dragon Age is pretty old now, but exploring elven ruins and slaying giant spiders never really loses its appeal.



Microsoft's *Ori and the Blind Forest* is beautiful, but for some reason, the game is a Windows-only affair. We got it running perfectly with DXVK.

> "As well as installing from your distro's packages, you could compile your own version of Wine, and include any experimental packages you like."

As well as installing from your distro's packages, you could compile your own version of Wine, and include any experimental packages you like, but Wine is a huge project and will take time and effort to compile, so this approach is not for the faint of heart.

Besides the two official versions (Stable and Development), a Staging version is available. This originated with the (now discontinued) Pipelight project, an effort to support the Silverlight browser plugin on Linux, which used to be our only recourse for watching Netflix and the like. Pipelight required its own version of Wine with features rejected for inclusion in mainline Wine. Even though we can now watch Netflix natively, there's still demand for experimental Wine builds, hence the Staging project. Until its inclusion in Wine 3.5, it was the most convenient way to get the CSMT (CommandStream Multithreading) patches, which in some cases offered an increase in graphics performance. But it's still a useful build for those wanting to see the latest features.

You may have read that Wine Staging was abandoned in mid-February, but fret not. As is the open source way, the project has been forked and is alive and well.

Advanged Google Search tips and tricks

Specify exactly what you need to find and narrow down your results by using advanced search tools.

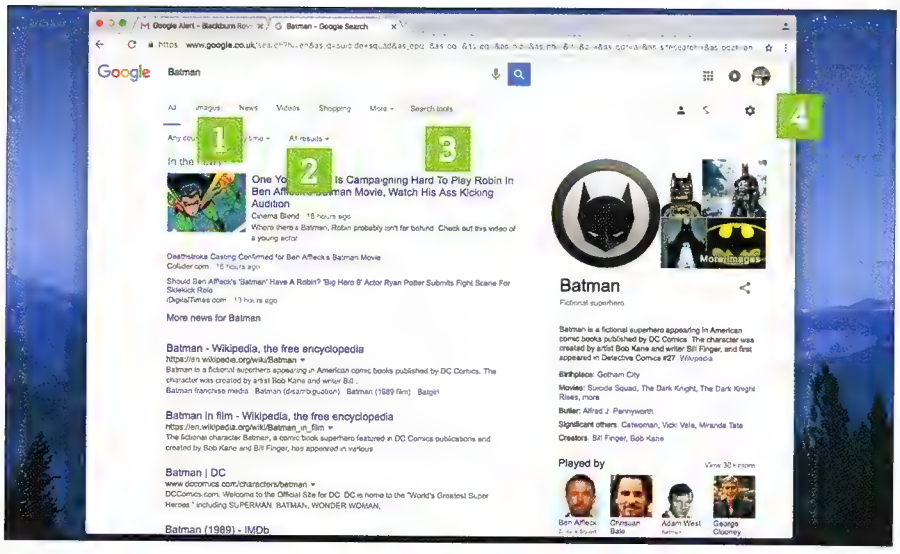
Most people use Google Search every day and accept the results that are presented. This is perfectly reasonable because the results are almost always accurate and fit the search term that has been inputted, but there are ways to improve your results.

Google offers many tools that will let you search for images, locations and other non-text references with ease and even these can be expanded upon to let you find exact image sizes and the type of images you require. The Advanced Search option lets you specify more than one term and you can choose what to include and what to avoid, which should bring results that are as near to your requirements as possible. The simplistic search page also lets you compare the prices of products, find books and apps, and jump to Google Maps if you need a particular location.

For most tasks, you will not need these tools, but for research and more serious undertakings, they offer a lot of benefits and time savings which should prove useful to you. If you use the search tools wisely, you will have the ability to find anything in seconds, despite the fact that the internet is an immeasurably large place.

Search layout

Lots of tools in one place.



SafeSearch

Google Search is designed to offer all of the results possible, but there will be times when you need to limit them. SafeSearch is available via the cog on the right-hand side of the search page and will filter out adult content from your results. It cannot do this 100% of the time, but is useful if you let your children use Google.

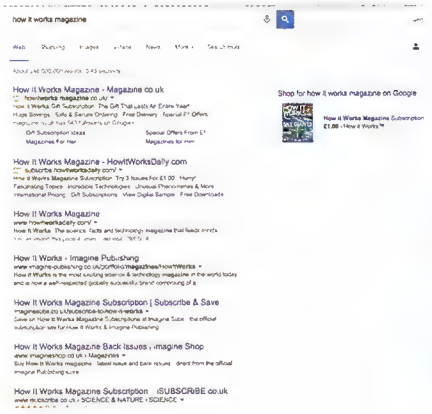
1 POWERFUL IMAGE SEARCHING
Image searching can be very precise. You can choose colours, exact sizes or even the style, such as faces or drawings.

2 TYPES OF RESULT
You can also specify where you want to get your results from. Blogs, discussions, patents and news sites are available.

3 LOCATIONS AND TIMES
Narrow down results by choosing when and where they are. Click 'Search tools' to bring up this row of powerful options.

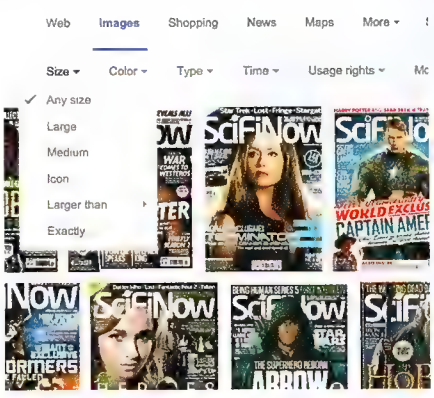
4 ADVANCED SEARCHING
Exact phrases, languages, reading levels and where terms appear on a page can be selected in the advanced search option. This lets you find the most obscure results.

Use advanced tools to search


how it works magazine
How It Works Magazine - Magazine.co.uk
How It Works Magazine - HowItWorksDaily.com
How It Works Magazine
How It Works - Imagine Publishing
How It Works Magazine Subscription | Subscribe & Save
How It Works Magazine Back Issues | Imagine Shop
How It Works Magazine Subscription

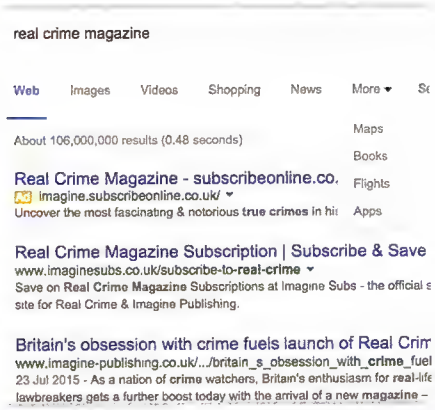
1 FIND THE OPTION

When you complete a search in Google, you will be presented with a standard list of weblinks, some of which contain further page links. Notice the row of options at the top.



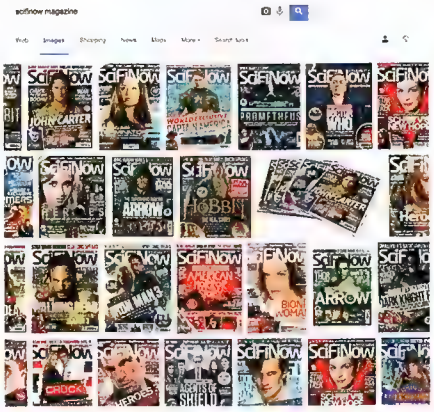
4 SIZES AND COLOURS

You can also click the 'Search tools' option and then choose what size image you need, a choice of colour and even the time it was published. This feature offers very specific searching.


real crime magazine
Web
Images
Videos
Shopping
News
More
Maps
Books
Flights
Apps
About 106,000,000 results (0.48 seconds)
Real Crime Magazine - subscribeonline.co.
Ad imagine.subscribeonline.co.uk/
Uncover the most fascinating & notorious true crimes in hi
Real Crime Magazine Subscription | Subscribe & Save
www.imaginesubs.co.uk/subscribe-to-real-crime
Save on Real Crime Magazine Subscriptions at Imagine Subs - the official s
site for Real Crime & Imagine Publishing.
Britain's obsession with crime fuels launch of Real Crim
www.imagine-publishing.co.uk/.../britain_s_obsession_with_crime_fuel
23 Jul 2015 - As a nation of crime watchers, Britain's enthusiasm for real-life
lawbreakers gets a further boost today with the arrival of a new magazine –

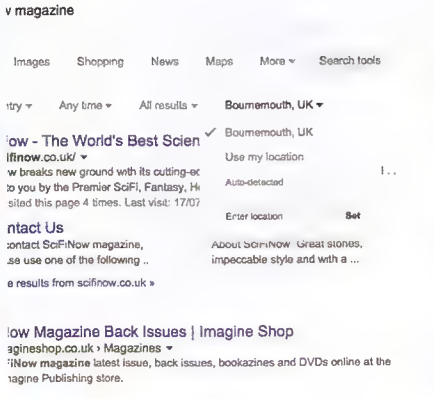
7 THERE'S ALWAYS MORE

The More option offers a method of narrowing down the results to blogs, news, videos and many other categories. This will let you find exactly what you need in a couple of clicks.



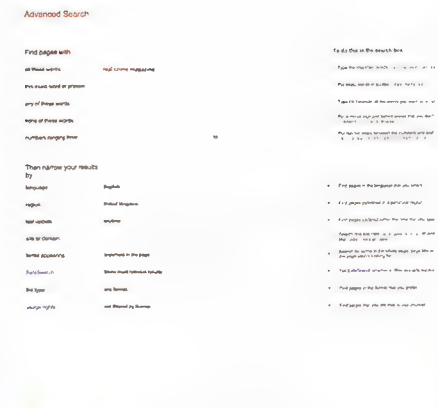
2 IMAGE SEARCHING

Click the Images option to be presented with a grid of related images. These are laid out in the most relevant order and not narrowed down in any way, but they can be.



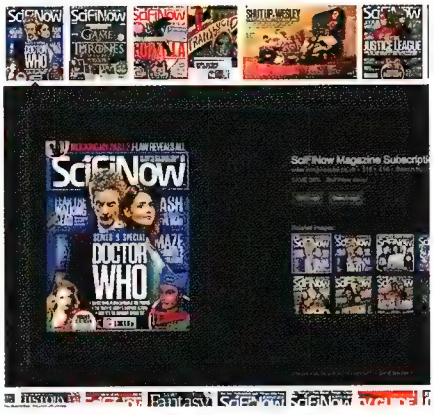
5 DEFINE PAGES

When in the standard Google Search view, click 'Search tools' again to choose locations, an exact time frame or only pages from your own country. You can even specify non-visited pages.



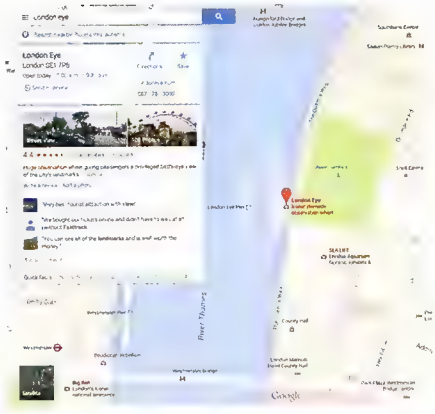
8 EVEN MORE ADVANCED

Tap the cog on the right-hand side of the page and you will see an 'Advanced search' option. Click it and take some time to check out all of the boxes on this particular page.



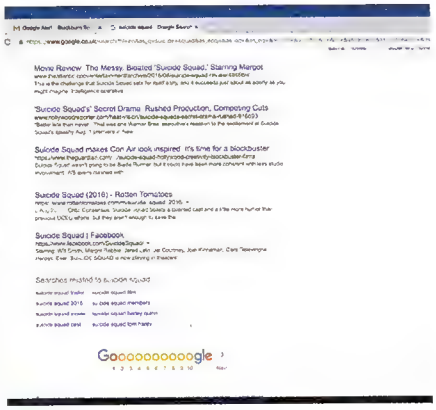
3 DETAILED IMAGE INFORMATION

Click on any image to see it expand and to view information about it. The size, a link to the original page and similar images are also shown. You can right-click to copy it.



6 WORDS AND MAPS

Clicking Maps will immediately present a Google Map showing the location of your search result. Multiple results will be listed on the left-hand side and one more click will present a new map.


Movie Review 'The Mersy, Boasted 'Suicide Squad,' Starring Margot
'Suicide Squad's' Secret Drama, Rushed Production, Competing Cuts
Suicide Squad makes Con Air look inspired. It's time for a blockbuster
Suicide Squad (2016) - Rotten Tomatoes
Suicide Squad | Facebook
Searches related to suicide squad
Gooooooooooogle

9 EXTREMELY SPECIFIC RESULTS

Once you have entered the exact parameters you are looking for, a standard search page will appear. Expect to receive no results on occasion, but it can be extremely accurate.

Build a super-storage showstopper

AMD's StoreMI offers up some enticing options for budget builders — Alan Dexter puts together a rig to see how it performs.

THE CONCEPT

The idea behind this build is a slight departure from the norm. We wanted to find out what AMD StoreMI was capable of. However, we also wanted to extend the ethos behind the tech to the rest of the system. StoreMI, in case you missed it, pairs a spinning hard drive with an SSD to potentially offer the best of both worlds – high-speed access with large capacities – something that would set you back a good chunk of cash if you were to simply buy a capacious SSD.

So the general ethos is great value for money, but it's more than simply focusing on the budget end of the spectrum – it's the best balance between value and performance out there. To this end, we've set out to build a machine that offers the best value for money right now. It isn't just that, though, because great value for money can cover a range of price points. There is something special about machines that cost around $1,800, and that's the price we've had in mind when building this rig.

So we have a tech we want to explore and a general price point, but what of the machine's purpose? Given the price point, it should be a mid-range machine that is capable of a wide range of tasks. The kind of general-purpose machine that is built every day, if you will. This also gives us chance to see how StoreMI works in a range of applications and situations, as well as a smattering of games.

As is always the case with these builds, you don't have to follow this build to the letter, and this is especially true here as we're trying to see how StoreMI performs; even so, the final build should stand on its own regardless. That said, let's look at the components we've decided to use...

THE SEARCH FOR VALUE

It's actually quite tricky in the current market to make a call on the best value gear, simply because a lot of our go-to components have seen their prices explode, meaning they're not as attractive as they once were. Graphics cards, in particular, have had a rocky ride recently, and while we once would have reached for a GeForce GTX 1070 for a mid-range rig such as this, these days, we have to set our sights a little lower, unless we want to bump into the $2,000 price bracket instead. This is why we've reached for a GeForce GTX 1060 6GB, although if gaming is of no interest, you can pick up a GTX 1050 instead for around $190.

For the heart of the system, we've elected to give the Ryzen 5 2600 a spin, and have paired it with one of the more affordable X470 motherboards around in the shape of the Gigabyte X470 Aorus Ultra Gaming. There are combo deals to be had with these two, so it's worth taking a look at your retailer of choice when buying, as you could save a few dollarydoos.

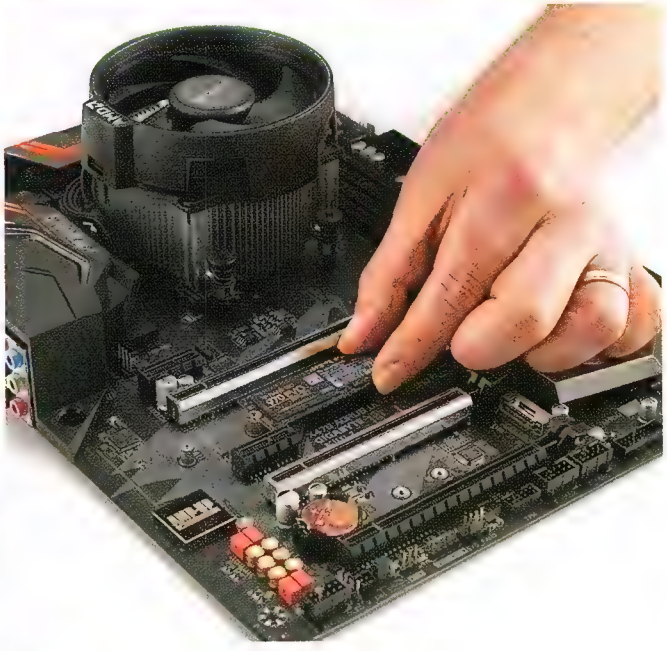
In order to test StoreMI, we've grabbed the recently released Samsung 970 Evo 250GB M.2 and paired it with a 1TB WD Caviar Blue hard drive. Amazingly, the new 970 Evo actually retails slightly cheaper than the older 960 Evos, so that's one of the easiest upgrades we've ever made. This build also showcases Cooler Master's newest case, the MasterBox MB500, which we're eager to build in again (see our review on page 29).

Finishing off the spec list, we've got 16GB of DDR4-2400 G.Skill RAM, and an affordable power supply from Cooler Master as well. Now that's all done, let's get building.

PARTS LIST

PART		STREET PRICE
CPU	AMD RYZEN 5 2600	$280
MOTHER-BOARD	GIGABYTE X470 AORUS ULTRA GAMING	$280
GPU	NVIDIA GEFORCE GTX 1060 6GB	$450
MEMORY	G.SKILL FLARE X SERIES 16GB (2X 8GB) DDR4-2400	$260
STORAGE 1	SAMSUNG 970 EVO 250GB M.2-2280	$160
STORAGE 2	WESTERN DIGITAL WD BLUE 1TB 3.5-INCH 7,200RPM	$65
CASE	COOLER MASTER MASTERBOX MB500	$115
PSU	COOLER MASTER MASTERWATT LITE 500W	$65
OS	WINDOWS 10 HOME	$130
TOTAL		$1,805

"We've set out to build a machine that offers the best value for money right now."

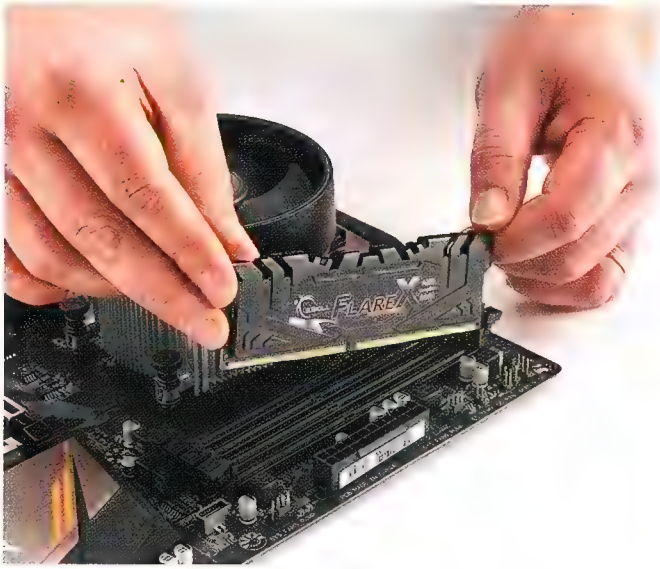


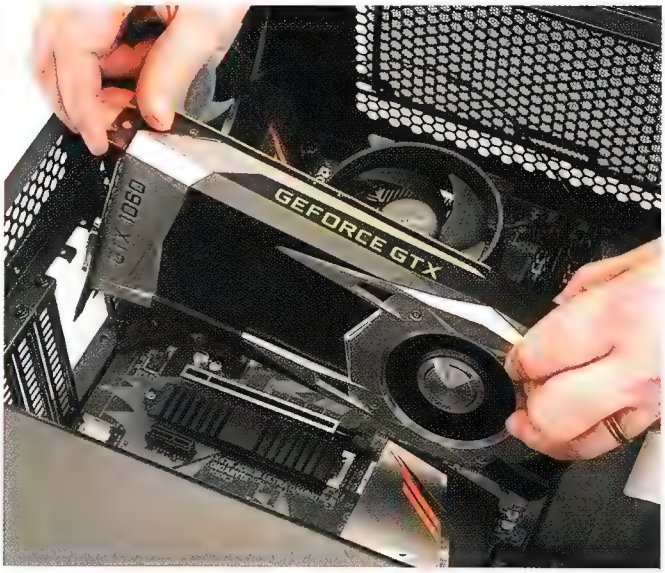
1 SWITCH COOLING

The Gigabyte X470 Aorus Ultra Gaming, like most AM4 motherboards, ships with support for clip-on coolers, but if you're using the Wraith Stealth cooler, as we are here, you need to unscrew the default brackets first. Once out of the way, you have to hold the backing plate in place, and then screw the Wraith Stealth into position. The best way of doing this is to work in diagonals — partially screw one corner into place, move to the opposite corner and partially tighten that one, then work on the other two corners. Once they're all in situ, you can finish off by tightening all four screws. Don't forget to attach the fan power cable to the motherboard, and you're done.

2 INSTALL THE M.2

Some items are easier to install before you slide the motherboard into place, and one of those is the M.2 SSD. Grab your trusty screwdriver, and release the heatspreader above the top M.2 drive slot. You should then unscrew the post from the bottom M.2 drive slot, and screw it into place, before dropping the Samsung 970 Evo into the slot, and securing it with the post you've moved. You can then peel the film off the heatspreader, and ease this down on top of the drive, before screwing that into place. This drive socket is completely hidden by the graphics card when you install that, so it's worth checking this is sorted before going any further.





3 CLICK INTO PLACE

We've elected to install the memory before slotting the motherboard into place, purely because doing so outside of the box gives us a little more space to work with. Check the motherboard to see which memory slots you should use first, as this should be printed on the motherboard somewhere (and it's rarely obvious). Once done, you should install the motherboard stand-offs into the case, then clip the IO backplate into place. You can now ease the motherboard into the chassis and screw it in place using the case's supplied screws. Keep an eye out for any stray cables that can get trapped under the motherboard if you're not careful — we moved the rear fan's cabling out of the way for this very reason.

4 GRAPHICS TIME

With the motherboard in place, you can now add the other components. When it comes to adding your graphics card, you need to remove the two PCI blanking plates before dropping the card into position. The MasterBox MB500 is a little odd here because there aren't any guides either side of the blanks, but you still can't go wrong. Once the graphics card is installed, hold it in place with the two screws. Next up, we installed the hard drive in the top of the hard drive cage, which can be found in front of the PSU at the bottom of the machine. The brackets for this are toolless, and really easy to use — just make sure you have the drive the right way around.

5 POWER UP

We're so used to modular power supplies here, that we're always a little shocked when handling a normally cabled PSU, but it really doesn't make that much difference (other than to your wallet). Release the two thumbscrews holding the PSU bracket in place, then attach this to your PSU, making sure that you've got it the right way so that the fan is pointing down. Thread the cables through the hole, then push the PSU into place, screwing the plate into position once you've made sure you haven't trapped any cables in the process. You can now attach the motherboard, graphics card and drive power cables, while trying to keep good airflow in mind.

6 LIGHTS, CAMERA, ACTION!

RGB lighting isn't something we usually get too excited about — in fact, we found the RGB-lit fans of the MasterBox MB500 overpowering — but there is a bit of lighting we do like, and that's the pairing of the motherboard lighting with the Wraith Stealth CPU cooler. Connecting the (incredibly long) cable that comes with the Wraith cooler to the LED CPU header, which can be found next to the top PCIe x1, lights up the ring on the cooler. You can change the colour of the motherboard LEDs and the Wraith in the BIOS, or by using Gigabyte's Windows app later on if you wish.
After a final check of your cabling, the hardware side of your build is finished.

1 The Cooler Master MasterBox MB500 ships with three LED fans, but you can run these without lighting up your case by simply not connecting them to your motherboard's LED header — just use the Molex connector on its own.

2 AMD's Wraith Stealth cooler is impressive — it runs quietly, while keeping the chip cool. (What more could you ask for?) The LED ring is subtle enough to keep us happy, too, and it's an easy way of seeing that everything is powered.

3 There's plenty of room in this case for a full-length graphics card, but the GeForce GTX 1060 is such a good card at 1080p, that we didn't feel the need to go any bigger. The fact that pricing has returned to normal helps, of course.

4 We could have done a better job with the cabling in this build, but we were so eager to get StoreMI up and running that we didn't spend the 15 minutes needed to just elevate this build above the norm. Still, there's good airflow in the case, so not much harm done.

Built for storage

There weren't any nasty surprises for us here, and the build process went without a hitch. We were momentarily confused by the lack of a securing post on the main M.2 slot, but realising we could borrow the one from the unused bottom slot, it didn't hold us back for long. You could argue that you don't need it at all, as the heatspreader holds it securely, but as our machines get couriered from the photo studio back to the office for testing, we prefer to overprovision, as opposed to finding our components rattling around later on.

Getting up and running with StoreMI wasn't as straightforward, however. After installing Windows 10 on the Samsung 970 Evo and downloading the drivers, we proceeded to completely mess up the install of StoreMI. We clicked the wrong checkbox, and instead of producing a super-fast hard drive, we ended up with a machine that wouldn't boot. Frustration set in as we couldn't then get Windows to see any drives, but after checking out the FAQ at **www.enmotus.com/amd**, we managed to grab the drivers and wipe the drives with DiskPart.

On the second attempt, we installed Win 10 to the hard drive, then installed StoreMI so the SSD was used to speed up that installation. This time, it worked without a problem, so we could get on with testing the performance of the drive tech and the rest of the machine. The performance garnered from this build was exactly what we expected in terms of the games suite and Cinebench score — this is a decent mainstream machine and no mistake. The fact that the Labs Test PC we use our masterclasses is a previous-generation Ryzen 5 1600 means that the figures really speak for themselves.

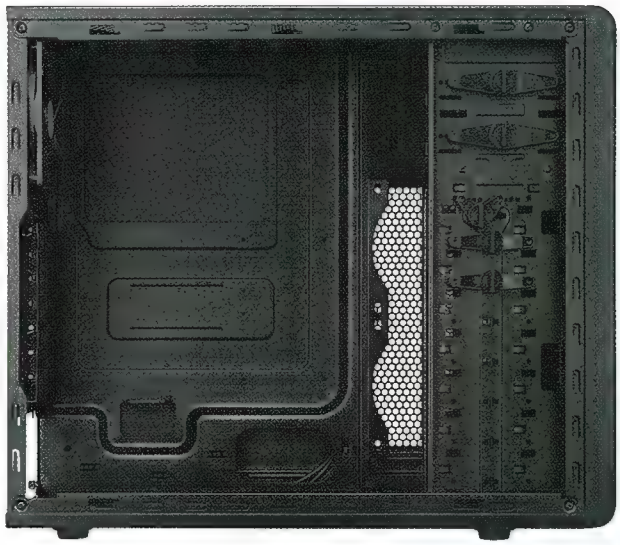
How about StoreMI? It's worth noting that a tiered drive system like this takes a while to kick in, and our performance metrics initially showed read performance more akin to what we'd expect from a spinning hard drive (around 180MB/s for sequential reads), albeit with PCIe NVMe write speeds. A few tests down the line, though, and the same benchmark produced the Samsung 970 Evo's normal read performance — the incredible read figures that you can see in the benchmarks on the left.

While it would be easy to see this as a problem for StoreMI as a technology, it's not as simple as that, especially when it comes to applications you use a lot. It performs exactly as you need it to where it counts. Essentially, if you use a lot of different apps, but rarely, a dedicated, large NVMe is definitely a better deal, but for a more focused selection of apps and games, StoreMI works well. ■

BENCHMARK RESULTS

	APC LABS TEST PC	THIS SYSTEM
CINEBENCH R15 MULTI (INDEX)	1,152	1,272 (10%)
CRYSTALDISK QD32 SEQUENTIAL READ (MB/S)	3,400	3,478 (2%)
CRYSTALDISK QD32 SEQUENTIAL WRITE (MB/S)	1,720	1,542 (-10%)
RISE OF THE TOMB RAIDER (AVG FPS)	60	77 (28%)
TOTAL WAR: WARHAMMER II (AVG FPS)	46	46 (0%)
TOM CLANCY'S GHOST RECON WILDLANDS (AVG FPS)	39	39 (0%)
3DMARK: FIRE STRIKE (INDEX)	11,101	11,337 (2%)

Our Labs Test PC consists of an AMD Ryzen 5 1600 @ 3.2GHz, 16GB Crucial Ballistix Sport LT @ 2,666MT/s, an EVGA GeForce GTX 1060 3GB, and a 250GB Samsung 960 Evo M.2 PCIe SSD. All tests performed at 1080p at highest graphical profile.



The Cooler Master N300 is a functional low-cost mid-tower case.

The $800 Intel PC build, revisited

Even on a very tight budget, you don't have to settle for a quad-core CPU. Darren Yates explains how to squeeze six-core Intel speed (and extra goodies) into a sub-$800 PC.

There's always plenty of friendly competition going on within APC, so when I saw Zak Storey's sub-$800 budget Intel build (Issue 454, page 92), I couldn't help but wonder if we could just tweak a little more out of it. Intel's Core i3-8100 CPU is a cracking chip, no question, but wanting more horsepower, I was on a mission – to squeeze a six-core Intel chip into the same budget, without losing any of the major components.

SPEND WHERE IT COUNTS

There's no doubt putting together a decent PC for under $800 is a tough ask and Zak's build certainly ticks all the boxes. However, even with a budget this tight, you can squeeze more speed out of it by skimping on the 'nice to haves' and keeping a really tight focus on your must-have features instead. For me, the 'must-haves' are processing speed, storage and high-quality PSU, so for this build, the foundation component has to be the CPU and Intel's cheapest six-core chip, the Core i5-8400, will set you back around $250.

Given Zak spent just $169 on the Core i3-8100, going with the Core i5 chip pushes us $80 into the red, but here's where we start scrounging back some of that extra spend.

When it comes to buying a motherboard on a budget, I'm firmly of the mind that a Z-series board doesn't do enough to justify the extra cost, especially in this configuration where you're only relying on integrated graphics and not overclocking. That's why I've gone instead for Gigabyte's GA-B360M-D3H – this more budget-friendly board uses Intel's B360 chipset, is $55 or so cheaper than the GA-Z370-HD3, but still gives you plenty of everything, including six SATA3 ports, 12 USB ports (half of which are USB3.1), plus four DDR4 RAM slots. What you don't get is the Z-series' built-in RAID support. However, the $55 we've saved here brings us back to just $25 in the red.

Speaking of RAM, there's money to be saved here as well – Team Vulcan RAM is fine, but at $145 for two 4GB sticks, there are more cost-effective

Kingston's low-cost SSDNow A400 gives our build 240GB of SSD storage.

Antec's HCG-520M PSU is likely based on Seasonic's M12II-520.

Intel's Core i5-8400 delivers six-cores for high-performance applications.

options available. Instead, I've selected an 8GB stick of Crucial DDR4-2400 selling online for around $120. The extra benefit here is that being a single stick, it leaves you three DIMM slots instead of just two for future RAM upgrades without replacement. The potential drawback is that, with no heatspreader on board, the Crucial RAM isn't suitable for overclocking, but then again, neither is the Core i5-8400 CPU nor the GA-B360M-D3H board, so heatspreaders are unnecessary. What's more, it saves us another $25 and we're back to all-square.

At this point, since Zak's build only cost $780, we're already well under our $800 target. However, we can still tweak some more value out of this build.

CASE AND PSU

I love BitFenix cases — they're reasonably priced, well designed and the Nova TG looks great. However, on a limited budget, I'd rather spend more on a rock-solid power supply unit (PSU). After all, a PSU is more important to your computing than a snazzy case. Now that doesn't mean you need to pick up a cardboard box from your local supermarket and make do, but any cash saved on a case can be put directly towards a higher-quality PSU. So here, I've dropped the BitFenix Nova TG case in favour of the cheaper Cooler Master N300 mid-tower, which you can pick up for around $60. I realise cases are a personal statement, but you should never judge a book by its cover, so they say! The N300 is a more conservative design, but if it means jumping from quad-core to six-core performance, my maths-heavy applications mean I'm taking six cores every time.

With the N300 selling for around $60 online, $15 less than the Nova TG, that's $15 more we can drop on a PSU. As a result, instead of the 450-watt EVGA 450 BT PSU, I've chosen Antec's HCG-520M. Like the EVGA BT, the Antec is only 80-Plus Bronze certified, meaning it's not as electrically efficient as the Silver and Gold rated PSUs. It also costs a little more, coming in around $80 online.

However, the main reason for choosing the Antec unit is that it's likely to be an OEM version of Seasonic's M12II-520. What do we mean by 'likely'? Neither Antec nor Seasonic have confirmed that this unit is a Seasonic build; however, Antec's 620-watt HCG-620M is known to be a rebadged Seasonic M12II-620, so we're fairly confident the 520-watt HCG-520M is a rebadged Seasonic M12II-520.

Why is that good thing? There are plenty of PSU brands on the market, but not so many PSU makers and Seasonic is generally regarded as the Rolls-Royce of PSU makers. Although the M12II is an older PSU design, Seasonic PSUs are usually built like tanks and as reliable as they come. You'll find the non-modular Seasonic S12II-520 PSU for around $95, but the Antec HCG-520M ('M' for 'modular' cables) sells for about $15 less.

PARTS LIST

	ZAK'S BUILD		DARREN'S BUILD	
PART	TYPE	PRICE	TYPE	PRICE
CASE	BITFENIX NOVA TG	$74	COOLERMASTER N300	$60
MOTHERBOARD	GIGABYTE GA-Z370-HD3	$189	GIGABYTE GA-B360M-D3H	$135
CPU	INTEL CORE I3-8100 (QUAD-CORE)	$169	INTEL CORE I5-8400 (SIX-CORE)	$249
MEMORY	8GB (2X4GB) TEAM VULKAN DDR4-2400	$145	8GB (1X8GB) CRUCIAL CT8G4D DDR4-2400	$120
PSU	EVGA BT 450W	$69	ANTEC HCG-520M 520W	$80
STORAGE 1	KINGSTON SSDNOW UV400 120GB	$65	KINGSTON SSDNOW A400 240GB	$85
STORAGE 2	WESTERN DIGITAL CAVIAR BLUE 1TB	$69	WESTERN DIGITAL CAVIAR BLUE 1TB	$69
TOTAL		$780		$798

> "When it comes to storage, having a dual solid-state/hard-drive strategy is the right way to go."

STORAGE

When it comes to storage, having a dual solid-state/hard-drive strategy is the right way to go — use the SSD for your operating system to maximise speed and keep the cheaper and slower HDD storage for your media files. The 1TB Western Digital Caviar Blue is hard to beat — I've been using these drives for years and they're terrific.

However, for the SSD, I've switched out the 120GB Kingston UV400. The UV400 has more or less been replaced at the entry level by the new A400 series, and although the A400 isn't quite as fast (you lose about 10% read/write speed), it's quite a bit cheaper. In fact, it's cheap enough that we can get a 240GB Kingston A400 SSD into our $800 budget. If you're not a Kingston SSD fan, you could choose Western Digital's 240GB WD Green SSD instead, although its price tag pushes us over the $800 mark by a few bucks.

Still, as we said before, shop around and you should be able to shave off a few dollars here and there — we've used an average of prices from ARC Computers (**arc.com.au**), Mwave (**mwave.com.au**) and Skycomp Technology (**skycomp.com.au**).

All up, it's been a good exercise in judicious pruning, with the result of gaining a six-core CPU, double the SSD storage and a Seasonic-grade PSU. In fact, I'll build this one myself!

Gigabyte's GA-B360M-D3H is a good budget Series-8 motherboard.

Emulate the Atari ST on a Raspberry Pi

Nick Peers pulls on a pair of baggy jeans and stripy top, and travels back in time to reveal how to transform your Pi into a fully fledged Atari machine.

You'll almost certainly remember the late '80s when the 8-bit computing revolution gradually gave way to the rise of 16-bit machines. Atari and Commodore stood at the forefront of this revolution, with the Amiga eventually winning out. But for a while during the late '80s and early '90s, the Atari ST ran it close. And thanks to the brilliant Hatari (hatari.tuxfamily.org), you can now resurrect the ST (and its successors) on your Raspberry Pi.

FIRST STEPS

You'll need a desktop environment to run Hatari – we're using Raspbian PIXEL. The latest version of Hatari uses SDL2 to render graphics, so you'll need to enable the OpenGL driver, noting that it's still experimental and may be slightly unstable. It also means Hatari requires a Pi 2 or better to run optimally.

To enable the driver, open a Terminal window, type: `sudo raspi-config` and hit Enter. Select 'Advanced Options > GL Driver > GL (Full KMS) OpenGL desktop drive with full KMS'. Reboot when prompted.

From here, installation is simple: open 'Pi > Preferences > Add/Remove Software', type "hatari" into the Search box and you'll see one hit: tick this and click OK to install it. Once installed, open the 'Pi > Games' menu – you'll see two entries: Hatari and Hatari UI. Choose the former option, where you'll immediately come across a message about not being able to load a TOS file.

TOS is the Atari's operating system, and comes in a range of revisions and versions depending on which 16-bit Atari machine you're trying to emulate. Technically, you should supply this yourself, but thankfully, the hard work of obtaining any version of TOS has been done for you.

Before proceeding, a quick note about legalities: when running emulator software, it's assumed in most cases that you own the original computer as well as any software you play on it. From a legal standpoint, you should really honour this, but practically speaking, there's nothing but your conscience preventing you from running whatever you like, even if it's no longer buried away in your loft somewhere.

Let's begin by obtaining TOS for Hatari. Open your web browser and head to **www.atariworld.org/tos-rom** where you'll find every single version of TOS from the original 1.0 release up to TOS 4.92 for the Atari Falcon. Which one do you need? It depends on what you're planning to emulate. The original STFM model, which covers most bases, runs best on TOS 1.4, but you may want to download TOS 1.02 for some older games. Those emulating the STE want TOS 1.62, while TOS 2.06 (both STFM and STE) is a good choice when copying lots of files via the ST's GEM desktop.

A word to the wise – the TOS 2.06 ROM file has the wrong permissions assigned to it – you need to right-click the IMG file after extracting it and choose 'Properties > Permissions'. Make sure 'View content' is set to Anyone and 'Change content' is set to 'Only owner' before clicking OK and copying the file across.

If you're determined to stay the right side of the law and have no Atari gathering dust in the attic, try EmuTOS instead (**emutos.sourceforge.net/en**). It's is a free version of TOS that can run on physical computers via floppy disk as well as your new Hatari emulator, but note it'll be hit and miss what games and software you'll be able to run on it.

When it comes to downloading each version, choose the English UK link. A zip file will be saved to your Downloads folder, ready for use shortly. You now have all the elements that you need to start configuring Hatari itself. The walkthrough over the page reveals the key steps you need to follow.

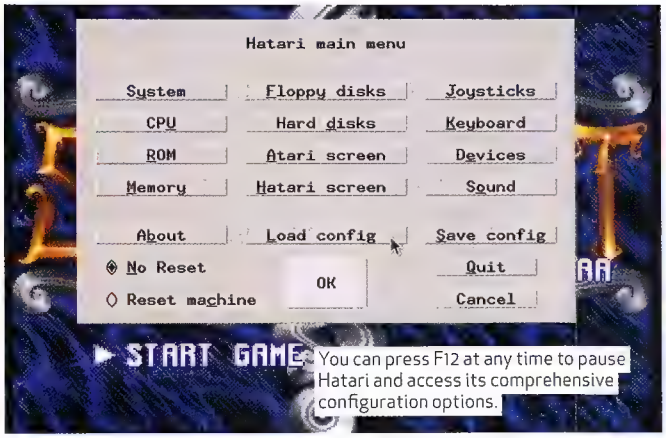
The Atari STE was capable of better graphics as this game — *Stardust* — clearly shows.

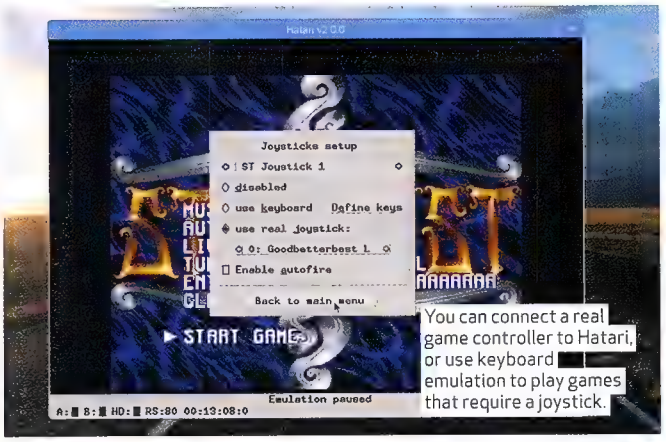
DOWNLOAD FLOPPY DISK IMAGES

As things stand, your Hatari setup is now a fully functional Atari machine – the only thing missing is software. Most games come on floppy disks, and once again, the painstaking process of converting ST floppy disks into image files recognisable by your Pi has been done by others. All you need to do is locate and download these images, which come in MSA, ST or STX format.

There are a wide range of sites offering images – Google 'Atari ST ROMs' for a long list. If you can cope with the fact it's French (Chromium will offer to translate the pages for you), then we like **www.planetemu.net/roms/atari-st-games-st** in particular. Here you'll find some games are listed several times based on who's submitted the images – try one and then download another if it doesn't work.

As with ROMs, floppy disk images are downloaded in zip format, so you'll need to extract them first, where you'll





be presented with files in .ST or .STX format (thoughtfully associated with Hatari, so you'll see a nice floppy ST icon to help identify them). These can be stored anywhere on your hard drive, but we recommend setting up a dedicated folder – say 'atarist' – inside your home folder for easy access.

PLAY ST GAMES

There are two ways to load floppy disks into Hatari. The simplest thing to do is simply browse to the folder containing your disks and double-click the .ST or .STX file. Hatari will launch using the configuration you've saved under hatari.cfg and then – after a pause that can be quite lengthy – the familiar green ST desktop will appear or the game will automatically load. Double-click the A drive icon if necessary, followed by the game file to start loading it.

If you plan to play a game that comes on two floppy disks, it's easier to start things off inside Hatari itself: press F12 to bring up the configuration screen and click Floppy disks. Click Browse next to Drive A to load disk one into Drive A, then repeat with Drive B for disk two. Leave 'Auto insert B' selected, then click 'Return to main menu', followed by OK.

Keep an eye on the status bar at the bottom of the screen, which should hopefully indicate the floppy disk is still loading. It can be a slow process, but there are some tricks to try. (One way to speed up load times, for instance, is to tick 'Fast floppy access' under 'Floppy disks' in Hatari's configuration. Another is to switch to 'Fast Forward' mode – press 'AltGr-X' to speed things up slightly. Press it again to return to normal speed.) Once done, the game's main screen should appear and it's then a case of navigating it with your mouse, keyboard or – if you've got one plugged in and configured – game controller.

To set up the latter, press F12 and click Joysticks. From here, you can select whether to disable the port, use a 'real' joystick or define the keys used to simulate the joystick, namely up, down, left, right and fire. Up to four ports can be configured – two regular ST joysticks plus two additional STE-only joypads.

When it comes to using a real joystick, any game controller that's plugged in and recognised by your Pi should be immediately visible – our wired PC/PS3 Gioteck controller was detected instantly, for example. As you'll have seen when defining keys to simulate a joystick, ST joysticks were basic and only supported four directions of movement and one fire button – use the analog stick and the top fire button to emulate the joystick, while the secondary fire button emulates the space bar key.

CREATE YOUR OWN BLANK FLOPPIES

If you're trying software that appeared on magazine covermount disks – such Future-published title *ST Format* – then chances are they were compressed to enable more content to be placed on the disk. You'll need to extract these to a separate 'disk' – we'll cover hard drives in a moment, but if you simply want to run them from their own virtual floppy image, click 'Create blank image' on the Floppy Disks configuration screen. Leave the default settings – 80 tracks, nine sectors and two sides – as they are, give your floppy a label and click Create.

Next, choose where to save the floppy – your default folder is best – and again name it for the game you plan to copy to it. Click OK, then Back followed by Drive B: to insert it into Drive B. You can now either copy the compressed file across before double-clicking it to unpack the game or use the covermount's own program to extract the files to the new disk. Be warned, it's a slow process, and you may end up having flashbacks, or perhaps that's just this magazine's former disk editor talking. Speaking of which, visit **www.exxoshost.co.uk/atari/STF** for a complete listing and download links for STF's disks.

BEYOND THE BASICS

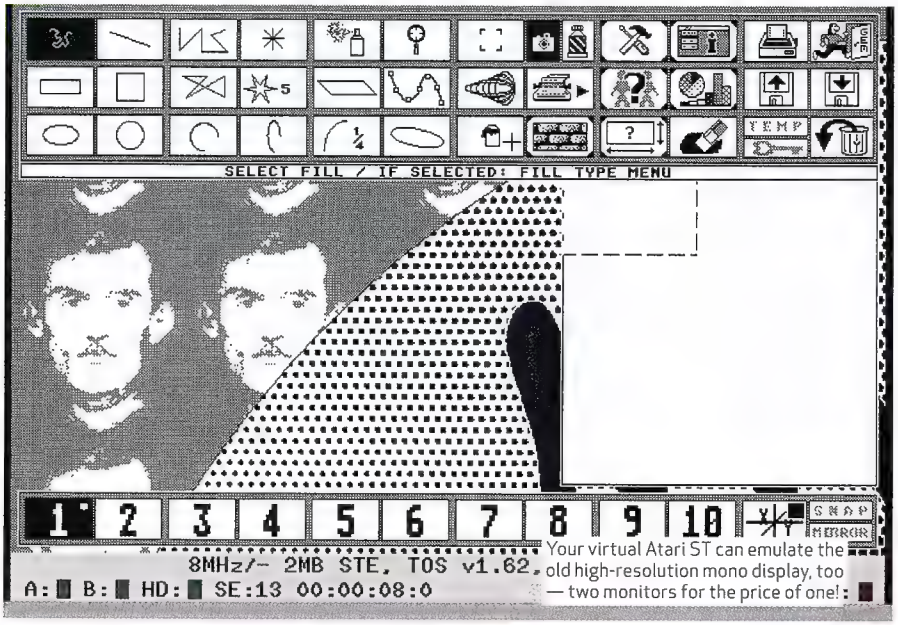
As things stand, you now have a fully

Solve compatibility issues

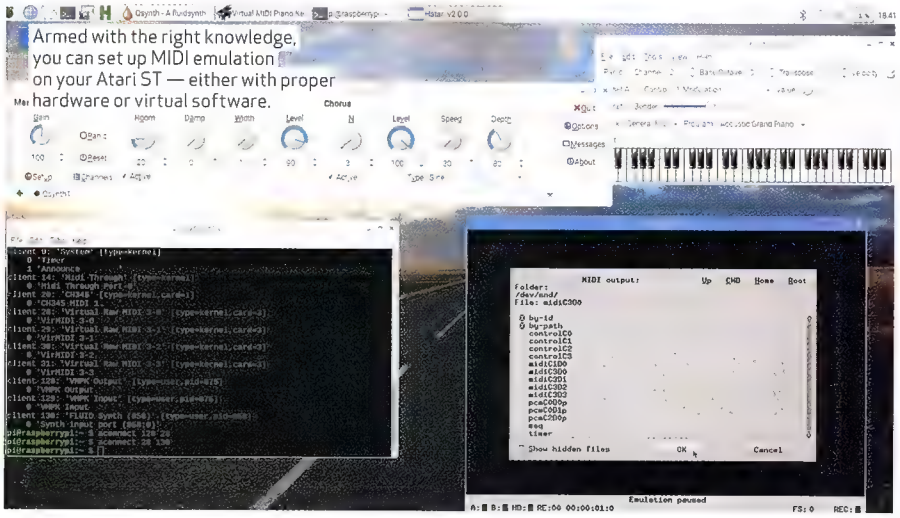
It all sounds so simple, and if you're lucky, you'll get to play a number of games before coming across one that doesn't appear to work. Start by visiting **bit.ly/hatari-compat** for a non-exhaustive list of ST programs that are known to cause problems. Failing that, check the website you downloaded the disk from to see if there's any specific configuration you should use. If you're running an older game, try switching to ST mode with TOS 1.02 for compatibility purposes.

Avoid allocating more than 2MB of RAM to your virtual ST, because timing issues can cause problems, too. 1MB should be ample for most games. Some games may require a NTSC (US English) TOS rather than the default PAL (UK English) TOS you've downloaded — simply swap them out and see if you're now lucky. Some games and demos are very particular about floppy emulation — press F12, click 'Floppy Disks' and untick 'Fast floppy access' to see if they're now able to load successfully. Other settings to tweak include unticking 'Boot Faster' and 'Patch Timer-D' under System. If there's screen corruption, also try different 'Video timing' settings.

Switching settings manually can be fiddly, but Hatari makes it possible to save multiple configuration files by changing the name of the .cfg file, enabling you to set up multiple setups (say STFM, STE and Falcon) and switch between them. Hatari will always load the hatari.cfg file by default on startup, but you can quickly switch by pressing F12 followed by Load config to choose another.



Your virtual Atari ST can emulate the old high-resolution mono display, too — two monitors for the price of one!



Armed with the right knowledge, you can set up MIDI emulation on your Atari ST — either with proper hardware or virtual software.

working Atari machine, running at decent speed. If all you're interested in is reliving some past glories, you should have everything you need to play games on your Atari. But you can push the envelope further, too.

First, look beyond the ST as a mere gaming machine – it was also renowned as a music-making tool and as the games market waned, major applications continued to be developed, from video editing and word processing to desktop publishing. Visit **www.planetemu.net/machine/atari-st** where you'll have access to a wider range of titles, including demos, magazine cover disks, public domain releases and applications.

As the number of titles grows, you may get tired of having to press F12 to swap floppy disks around. Use the 'AltGr-D' to swap disks, followed by 'AltGr-R' to perform a warm reset or 'AltGr-C' for a cold reset. Alternatively, why not connect a virtual hard disk to your ST – the box reveals the simplest way to add a single 80 MB ACSI hard disk. You can duplicate this blank image file to create multiple hard disks, but you can only connect one at a time.

Another option is GEMDOS, which enables you to mount a folder on your Pi's storage as a virtual drive, making it easier to copy files directly to the drive from your Pi storage. Note, however, that you'll either need a dedicated hard disk driver or access the drive using EmuTOS, which supports GEMDOS natively.

If you find yourself getting into an old game or two, you may want to know how to save your progress. If the game itself has a save option, you could always create a blank floppy image as outlined earlier and insert it into Drive B. Alternatively, you could use Hatari's own memory snapshots feature, which are obviously quicker.

Start by pressing F12 and selecting Memory. Click Save, type a suitably descriptive filename (with the all-important .sav extension) and click OK. Return to your game, pressing 'AltGr-K' at any time to update the saved file with your latest progress, or 'AltGr-l' to reload your last saved state.

You can also snap screenshots at any point – press 'AltGr-G' to take a screen grab in PNG format. Press 'AltGr-A' to record an AVI movie (you'll see the Rec button turn red in the Hatari status bar), and press it again to stop recording. Finally, press 'AltGr-Y' to start and stop recording your ST's sound. All recorded material can be found in your home folder.

MIDI FOR MUSICIANS

The ST was a big draw from musicians with its built-in MIDI ports and was used by major artists including the likes of Queen for The Miracle. If you have a USB-to-MIDI cable then you can hook up a MIDI keyboard to use with the likes of Cubase.

First, you need to verify your cable has been detected by Raspbian. Open a Terminal window and type the following:

```
$ lsusb
```

Create a virtual hard drive

Floppy disks are slow. Attach a virtual hard drive and loading times are quicker and you can switch between programs without having to swap out disks. Hatari supports three type of emulated hard drives: ACSI, IDE and GEMDOS. Of these, ACSI is the most compatible option and works with all versions of TOS from 1.02 up.

ACSI emulated drives exist physically as an IMG file and can be fiddly to set up, plus they require drivers placed on the virtual hard disk to work correctly. Thankfully, Hatari provides you with an empty 80MB hard drive image, which you can download from **hatari.tuxfamily.org/hd80mb.image.gz**. Extract the hd80mb.image file to a suitable folder, then open Hatari's configuration, select Hard disks and click Browse next to ACSI HD image to select the file.

Reboot your ST and you'll see a new Drive C appear, which you can copy files to. Note that many commercial games will refuse to run from hard disk. For those that do (such as *Civilization*), just keep your games in separate folders and make sure you save your configuration, so the hard disk is always accessible whenever you start your virtual ST.

You should see your MIDI adaptor listed. Now type the following, which should verify at least one MIDI port is available.

```
$ aplaymidi -l
```

If they're available, open Hatari and press F12, then click Devices. Click the two Browse buttons under Enable MIDI emulation and point them to whichever midi entry appears under /dev/snd. Tick 'Enable MIDI emulation' and restart your virtual ST.

If you don't have a MIDI device, try a software MIDI synthesiser instead. First, install Virtual MIDI Piano Keyboard (search 'Pi > Preferences > Add/Remove Programs' for 'vmpk').

Next, launch QSynth from 'Pi > Sound & Video', followed by VMPK. In VMPK, select 'Edit > Connections', click the Output MIDI connection and choose 'FLUID Synth' to connect the two. Hit the virtual keys and you should hear sound to verify that it's working correctly. Now open a Terminal window and type the following:

```
$ sudo modprobe snd-virmidi
$ aconnect -i -o
```

Make a note of the client numbers and then type the following:

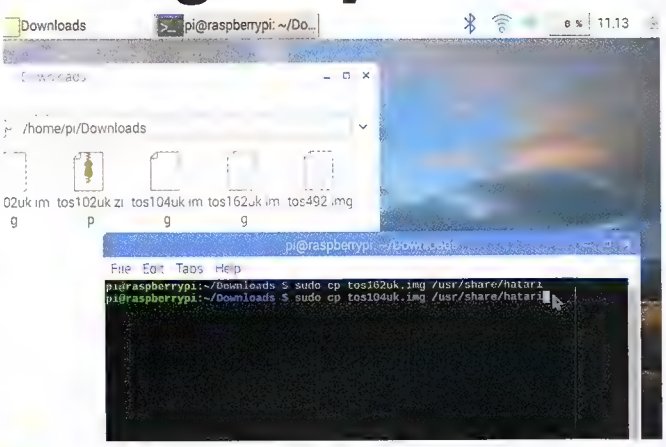
```
$ aconnect <sender>
<receiver>
```

Substitute `<sender>` with the client number of VMPK Output and `<receiver>` with the client number of the first Virtual Raw MIDI port. Now repeat the command, this time substituting `<sender>` with the Virtual Raw MIDI port, and `<receiver>` with Synth input port – for example, like this:

```
$ aconnect 128 28
$ aconnect 28 130
```

Now open Hatari, press F12 and click Devices, then point it towards the correct connection. Tick 'Enable MIDI emulation', and you should be able to use your virtual synthesiser to input music into sequencing software like Cubase while listening back through Qsynth. Job done!

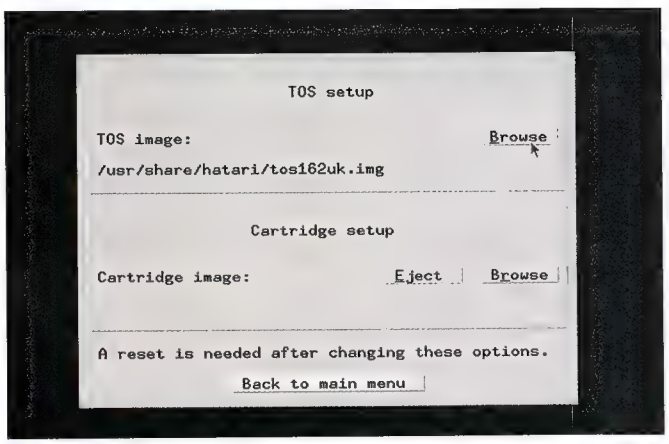
Configure your virtual Atari ST



1 COPY TOS FILES

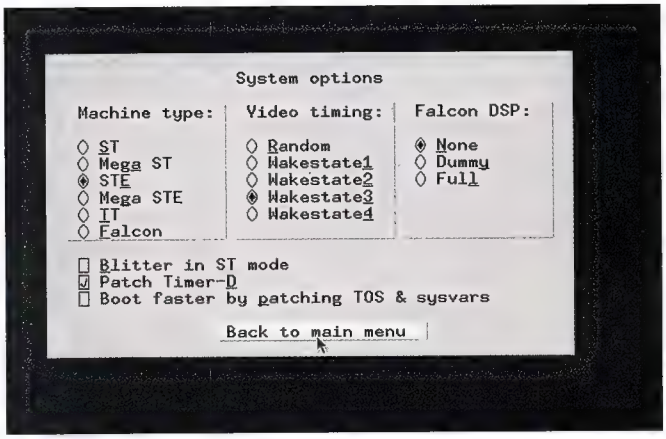
Open File Manager. Double-click the downloaded TOS zip file to open it in Archive Manager, then drag the .img file into your Downloads folder. Once done, press F4 to open a Terminal window pointing to the Downloads folder and type the following (substitute `tos102uk.img` with the image file):

```
$ sudo cp tos102uk.img /usr/share/hatari
```



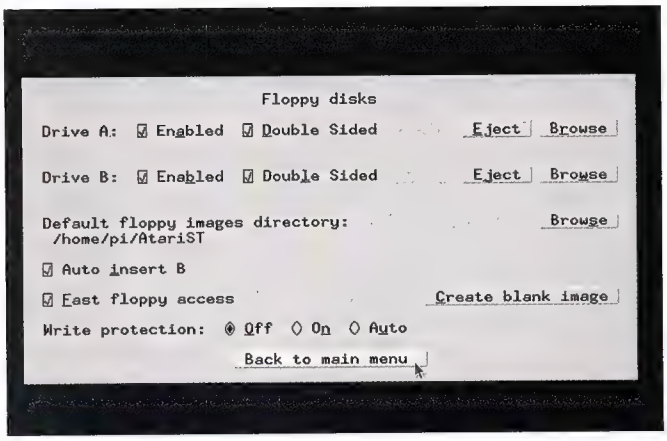
3 SELECT ROM AND RAM

Return to the main menu and click ROM. Click Browse to select the TOS image you copied across in step one — make sure it matches the Atari machine you're emulating. Click 'Back to main menu' again, then click RAM. By default, 1MB is allocated, which is sufficient for gaming — drop this to 512K for some older games if they refuse to load.



2 SET SYSTEM TYPE

Now open the Pi menu and select 'Games > Hatari'. Click OK at the 'Could not load TOS file' screen. When the main menu appears, click System. By default, Hatari is configured to emulate the STFM, but you can select a different Atari machine from the list. Tick 'Boot faster by patching TOS & sysvars' regardless of which machine you choose to speed loading times slightly.



4 SELECT FLOPPY DISK AND SAVE CONFIGURATION

Now click 'Floppy disks' followed by Browse next to 'Default floppy images directory' to select the folder you've stored your disk images in. Tick 'Fast floppy access to help speed up loading times', but note that some disks may not work (in which case unticking this may help). Click 'Back to main menu', followed by 'Save config' to save your setup.

Take Android audio to the next level

If music is your way of life, don't settle for 'good enough'. Darren Yates looks at the next-generation techniques for improving audio quality from your Android device.

Mobile audio has been under the blowtorch for the last year or so, thanks to the decision by some phone makers to begin ditching the 3.5mm TRRS (tip-ring-ring-sleeve) socket on flagship models in favour of wireless technologies. However, with so many different audio standards, formats, devices and codecs on the market, buying a high-quality mobile-ready digital audio solution is more complicated than ever. This month, we look at what's happening in Android audio and how to navigate through the maze of options.

WIRED OR WIRELESS?

As high-end phones start waving goodbye to the classic 3.5mm stereo audio socket in favour wireless digital earbuds and headphones, choosing between wired and wireless is an issue you're likely to face the next time you go for that flagship phone purchase. Thankfully, though, it's not quite that black-and-white – even as the 3.5mm socket disappears, it doesn't mean the end of wired audio. No, we're not suggesting you take to your phone with 3.5mm drill bit, but it does mean there's now significant fragmentation in the mobile audio market. When all you needed to think about previously was the sound, now, you have to consider the full audio chain from your phone's storage right through to the earphone diaphragms pumping sound waves into your ears.

WHAT'S WRONG WITH BLUETOOTH?

Bluetooth audio has copped its share of flack over the years – some say deservedly so, while others are wowed by the audio quality coming from their Bluetooth devices. Why the disparity? It's partly expectation, but mostly the device doing the Bluetooth-ing. You may not know it, but most Bluetooth audio is actually compressed twice – once by the original audio codec (MP3, AAC or whatever) and then again by the Bluetooth device. The original Bluetooth audio system or 'profile' that's been around for years is Advanced Audio Distribution Profile (A2DP), a wireless transmission protocol for sending digital audio. However, due to bandwidth restrictions, Bluetooth incorporates its own lossy (as in, not all data is kept) codecs to compress all audio it transmits. What's more, A2DP has only one mandatory codec that must appear in every Bluetooth A2DP device and that's low-complexity sub-band coding (SBC). If Bluetooth has copped a bad rap, it's likely due to SBC. You may have heard there are alternatives to SBC available, but to use them, both the transmitting and receiving devices must support the codec alternative, otherwise, the system drops back to the default SBC.

However, the problem with A2DP isn't just to do with SBC, although with a top rate of just 345Kbps, SBC isn't going to make any audio purist's playlist. But take into account the double-layer of compression occurring when you feed already-compressed audio through SBC and it's a bit like putting your food through the microwave twice.

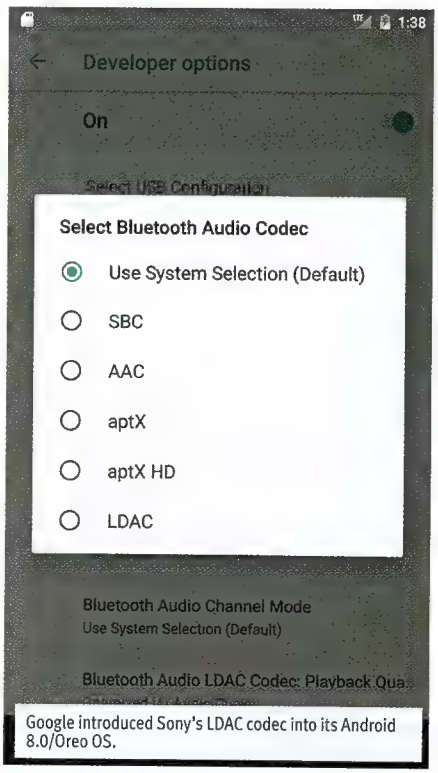
APTX OR APTX HD

Phone-chipmaker Qualcomm decided it was time to do something with Bluetooth and now embeds its own codec alternative in all new Snapdragon phone CPUs called 'AptX'. It's still a lossy codec, but instead, it's based on 'adaptive differential pulse coded modulation' (ADPCM) and without the psychoacoustic modelling of SBC. As for its bitrate compression, AptX squeezes a 1,411Kbps stream of 44.1kHz/16-bit stereo audio down into 352Kbps of wireless data for a 4:1 compression ratio. AptX's bit rate is much the same as SBC's top-rate, but the AptX codec itself provides the audio improvement. Still, as we mentioned, you must have AptX codec support in both the transmitting and receiving devices for it to work – without it, your Bluetooth link will drop back to SBC.

To tap into the growing high-resolution audio market, Qualcomm released 'AptX HD' in 2016, boosting the audio sample rates from 44.1kHz/16-bit to 48kHz/24-bit. It works along similar lines to the original AptX codec, but Qualcomm says it uses the extra bit-depth to improve the overall signal-to-noise ratio (SNR), giving an electrically quieter result. It also pushes the Bluetooth data stream rate up to 576Kbps, so like AptX before it, AptX HD requires you have support in both the transmitting and receiving devices before it'll work. At the moment, it's still early days and relatively few phones and headphones incorporate it so far.

LDAC

Meanwhile, home-entertainment giant Sony took Bluetooth audio up yet another notch, developing its own codec called LDAC. This codec can stream high-resolution audio with sample rates of up to 96kHz/24-bit using Bluetooth and transmissions



Google introduced Sony's LDAC codec into its Android 8.0/Oreo OS.

Audioengine's B1 wireless audio receiver supports AptX over Bluetooth.

Google's Chromecast Audio is the cheapest Wi-Fi option to handle LPCM.

rates pushing 1Mbps. There are three official LDAC transmission rate options – 330Kbps, 660Kbps and 990Kbps. The higher the send-rate, the higher the audio quality.

Of the various post-SBC solutions, LDAC looks the one most likely to appeal to purists from a technical viewpoint, thanks to its higher bitrate and sample rate support. However, it could well appeal to the rest of us as well – Sony donated LDAC to the Android Open-Source Project (AOSP) for inclusion from Oreo/Android 8.0. Yet, while LDAC is already available by default in new Oreo phones, again, there hasn't been a huge rush of headphone makers to support LDAC, other than Sony itself. That said, Sony's WH1000XM2 headphones support AptX, AptX HD, LDAC and even AAC, but they'll also set you back $500. Still, if you'd prefer a more group-friendly option, Sony's CMT-SX7B micro system looks like the 'Swiss army knife' of wireless options, combining Bluetooth and LDAC support with built-in Wi-Fi and Chromecast.

BLUETOOTH 5.0

While AptX and LDAC are effectively stuck with Bluetooth 4.2's current A2DP bit rate limits, Bluetooth 5.0 potentially offers double the audio data, up to 2Mbps, which, for the first time, would be enough to send up to 48kHz-stereo audio in uncompressed 16-bit LPCM format – in other words, better than raw CD-quality. The only problem is that no new Bluetooth 5.0 A2DP codecs have been announced yet and until that occurs, LDAC looks to remain the best show in town.

Where Bluetooth 5.0 should shine, though, is with range and efficiency – it's designed to offer four times the range of Bluetooth 4.2 with the choice of reducing range for longer battery life (although this is probably more about Internet of Things than digital audio).

CASTING

However, if the problem with Bluetooth is the lack of bandwidth, what about using Wi-Fi instead? Well, that's what many of the home entertainment brands do – although often, it's more 'wireless' than strictly 'Wi-Fi'. This becomes apparent once you start building with a brand and find you're pretty much locked in, thanks to the general incompatibility between them. For example, Yamaha MusicCast devices talk to other MusicCast devices, the same, too with Sonos, Bose and Samsung wireless speaker systems. What they don't often do (if ever) is talk to each other. However, it also depends on the type of system you're trying to build – integrated wireless speakers you dot around your home tend to be a lock-in, but if you're after a more traditional multi-speaker home-theatre setup, the old-school multi-channel receiver from the likes of Onkyo, Denon or Yamaha often include multiple wireless options.

Still, the simplest place to start for most of us is Google's Chromecast Audio dongle. For its $50 price tag, Chromecast Audio is much like its Chromecast video sibling in being a mini ARM Cortex-A single-board computer you control via your Android phone/tablet. The major differences between the two is the 2GB less of RAM you get in Chromecast Audio and its added 192kHz/24-bit stereo DAC. What's more, it may not be obvious, but Chromecast supports a couple of high-performance audio codec options, including straight up Linear Pulse-Coded Modulation (LPCM), the stuff audio CDs are made of, plus the popular lossless codec, FLAC, up to 96kHz/24-bit.

Connect your Chromecast Audio into a decent sound system and provided your original audio is up to

Audio Technica's DSR9BT headphones are AptX HD-ready.

Sony's WH1000XM headphones add noise-cancelling to LDAC support.

LG's G6 phone is one of a handful to support Qualcomm's AptX HD codec.

Google's Pixel 2 XL, one of a number of phones with no 3.5mm audio socket.

Samsung's Galaxy S9 phone joins the growing list with Bluetooth 5.0.

scratch, your sound system should be the limiting factor. So if you have a good audio setup already, a $50 Chromecast Audio dongle could be just the ticket.

USB-C HEADPHONES

As USB-C increasingly becomes the only wired port on new high-end phones, we're beginning to see the arrival of USB-C headphones onto the market. However, choosing a model requires far more research than just whether or not they look or sound any good.

The USB-IF (USB Implementers Forum) group charged with setting the USB standards decided to make USB-C versatile enough to handle multiple audio options. The first is the active digital option, whereby USB-C headphones integrate digital-to-analog converter (DAC) and amplifiers inside the headphones themselves. This offers the benefit of the USB-C cable simply carrying power and digital data, while the headphones are now the final arbiter of the audio quality you hear. Even if your phone has a dud DAC, it's ignored in this case and replaced by the DAC in your headphones.

However, things are rarely this simple – not all USB-C headphones work on all USB-C phones, so you must make sure you test before you buy.

USB-C TO 3.5MM ADAPTERS

If you have a decent set of passive analog headphones you're not ready to ditch just yet, the other cost-effective option could be a USB-C to 3.5mm adapter cable. However, just like USB-C headphones themselves, you need to choose carefully.

There are two types of adapter – active and passive. The passive adapters are the cheaper of the two and basically little more than wire connections – not because they're fake, but because they're designed for USB-C's Audio Adapter Accessory Mode. This is the second option built into the USB-C standard and allows phones to send traditional analog audio out through three pins on the USB-C port instead of a dedicated 3.5mm socket. The problem is not all USB-C phones support Audio Adapter Accessory Mode, meaning you must check yours does before looking for passive adapters.

The alternative 'active' adapters integrate the DAC and amplifiers

Onkyo's TX-NR474 includes Play-Fi, Chromecast and dual-band Wi-Fi.

Razer's Hammerhead USB-C earphones feature built-in DAC and USB-C plug.

Sony's CMT-SX7B HiFi system includes LDAC/Bluetooth and Wi-Fi/DLNA.

within the adapter module. They feed on power and digital data in much the same way as integrated USB-C headphones, but output via 3.5mm socket to standard analog headphones. Again, you must ensure any USB-C active adapter works with your phone before you buy.

One massive boost for using active USB-C adapters is the potential for supporting what's known as USB Power Delivery 'Dual Role Power' (DRP). Phones with older USB-OTG ports can only output power to a hosted USB device – they can't accept power while the microUSB port is in 'host' mode (this is why, for example, you can't charge your phone while powering an external DAC via USB-OTG). With DRP, however, you can – but in fear of sounding like a broken record, check the adapter and your phone both have this option before you buy.

WHICH OPTION SOUNDS BETTER?

Beauty might well be in the eye of the beholder, but in this case, it'll be more likely in your ear. If you're an audio purist and listening to anything compressed is sacrilege, you're unlikely to choose Bluetooth. The compression required may be unnoticeable to most listeners, but even with AptX HD and LDAC, you still have a form of compression. However, it'd worth testing yourself before throwing the baby out with the bathwater.

Beyond that, you still have Wi-Fi/wireless and wired options, but even here, it's not so much having active or passive headphones, but where the audio signal comes from.

With my electronics hat on, the proximity of high-speed digital data lines to the analog audio pins inside the USB-C connector in Audio Adapter Accessory Mode leaves me wondering about the possibility of digital interference or 'crosstalk' on the audio output. Smartphone printed circuit boards are so compact that it has to be more difficult to route analog and digital connections around the board in a way that minimises interference and digital noise leaking onto those analog audio circuit board traces. By contrast, keeping the DAC and headphone amplifier outside the phone gives you more control over the analog path, enabling the engineer to more easily create an electrically quieter and cleaner setup. The downside of an external DAC is you have more gear to power and carry around with you. Google says something similar in a section of its 'USB Digital Audio' Android page (**tinyurl.com/mgmmyq2**) called 'a tale of two DACs'. It outlines the technical issues facing phone engineers on how best to output analog audio. This isn't to say Audio Adapter Accessory Mode can't work – in fact, we're keen to understand how it avoids issues of digital interference in the analog output.

YOU CHOOSE

Ultimately, phone audio is all about deciding where and when you perform the crucial DAC process – do you do it on the phone for zero extra cost, externally in a separate module for maximum quality you have to carry around, or bundle it right into headphones that can cost a small fortune? Each method has its benefits and drawbacks, depending on which factor is more important to you.

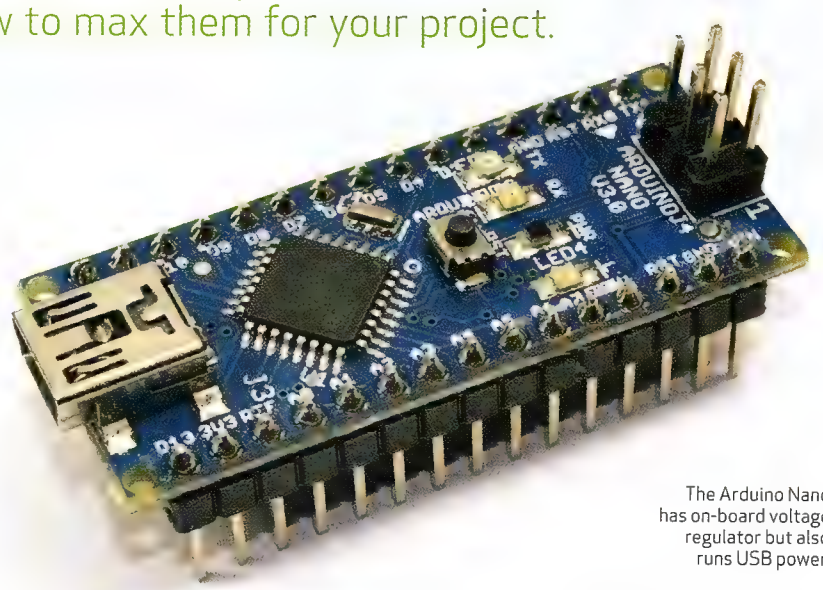
One thing is for certain – it's all a lot more complicated now than a 3.5mm stereo socket. ■

Google's USB-C to 3.5mm adapter supports analog headphones on Pixel 2.

How to power your Arduino projects

There are many different ways to power your Arduino projects besides the traditional 9V battery. Darren Yates explores the options and how to max them for your project.

Many Arduino-style development boards are well-suited to battery power, but how do you determine the best power option? Look around on the web and you'll find plenty of boards powered by simple 9V smoke-alarm batteries, yet, in many cases, they're a poor choice. They might be small and convenient, but 9V 'PP3' smoke-alarm batteries have comparatively low capacity, aren't particularly cheap and usually can only power an Arduino board and a couple of LEDs. If you consider Internet of Things (IoT) and motorised projects that have to run without mains power, sourcing the right power for your project becomes paramount. So this month, we're looking into the various power options – and none involve a 9V smoke-alarm battery!



The Arduino Nano has on-board voltage regulator but also runs USB power.

GET THE VOLTAGE RIGHT

The first rule with supplying power to development boards is to get the voltage right – feed too much voltage into a development board and it'll likely blow up. What makes things trickier is that some development boards have microcontroller chips requiring 5VDC, others have chips needing 3.3VDC. That's why many boards feature electronic circuit components called 'linear voltage regulators' – these cheap, easy-to-use components fix or 'regulate' a higher voltage down to a level required by the board.

USB PORTABLE CHARGERS

But if your development board can be powered via USB port, one of the simplest solutions is a portable USB power bank. You can find these almost everywhere for as little as $10 for a 2,200mAh capacity, with a microUSB port to charge the charger up and a standard Type-A port to plug in your device. Normally, you'd charge up your phone with one of these, but they're also excellent for USB-powered development boards. For example, if your Arduino Uno or Nano-based project consumes on average 40mA of current, that 2,200mA portable charger should in theory power your project for around 55 hours. Here's the equation:

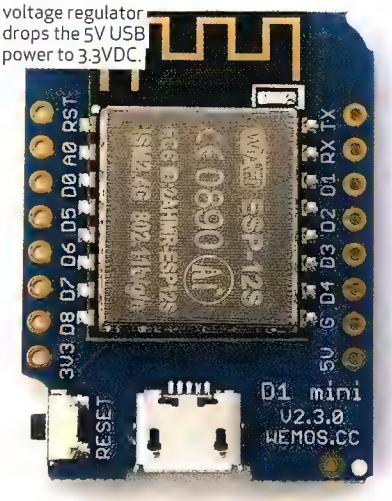
Run-time (hours) = battery capacity (mAh) / project current (mA)

One of these will last much longer than a 9V PP3 battery and pay for itself within a few recharges and you should get around 400–500 recharge cycles before you need to think about replacing it.

WIRELESS CHARGER

Then again, you could forego any direct connection to a power source and power

The AccuPower IQ338 charges up to four 18650 or NiMH cells at once.



The WeMos D1 Mini's voltage regulator drops the 5V USB power to 3.3VDC.

Plug this wireless charger into your microUSB board for power without wires.

Place the wireless charger on this powered charge plate for wireless power.

your project wirelessly. It sounds complicated, but actually, it's another power option we've stolen from new mobile phones. Online, you'll find lots of 'Qi wireless charging receiver' modules the size and thickness of a credit card with a moulded microUSB connector on the end. Plug this into the microUSB port of your development board and lay the receiver card on top of a Qi wireless transmitter disc, which often look like a flattened hockey puck. Plug the transmitter disc into your phone charger and your development board should fire up.

Why use wireless power when you could just plug the phone charger straight into your development board? Wireless power is ideal for applications where you need to keep the project completely sealed (think *Star Wars*' BB8 and you hopefully get the idea).

The market is awash with add-on Qi-format wireless charging – you'll find wireless receiver cards capable of supplying 5V/500mA of power and power transmitting discs on eBay for as little as $2 each, including shipping.

This SD card-sized step-up converter outputs 5VDC via its USB port.

STEP UP THE POWER

You may not know it, but many of the portable chargers you'll find on the market are powered by a single 18650-type Lithium-ion battery, the type Tesla uses by the train-load in its electric cars. But these 18650 cells only deliver 3.7VDC, so how can one cell generate 5VDC on the USB port to charge your phone? Where does the missing 1.3VDC come from? The trick is a small circuit inside called a 'DC-DC step-up converter'.

These step-up converter modules are often as small as a microSD card. They can accept input voltages from as little as 0.8VDC and output 5VDC via a USB Type-A port. Connect your battery to the module's input terminals (observing correct polarity) and you can power your board via its USB port, possibly doing so using just a single AA-size NiMH rechargeable battery.

Just keep in mind that step-up converters essentially convert current to voltage, so roughly, the ratio between input and output voltages is the ratio between output and input current. For example, if the input voltage is 2.5VDC (two AA NiMH cells, for example) and the converter outputs 5VDC while your project consumes 50mA of current, the input current from the two AA cells at minimum has to be (5/2.5) x 50mA or 100mA, assuming the conversion process is 100% efficient. In practice, it never is – typically, it's 90–95% at best, so, in this case, the input current would be closer to 110mA. Still, two AA cells usually deliver 110mA for longer than a 9V smoke-alarm battery can output 50mA.

What's more, step-up converters can be useful in applications normally using two separate batteries. For example, robots like our recent Rocket robot are often designed to use one 9V smoke-alarm battery for the Arduino board

The Opus BT-C700 is a greater little NiMH AA/AAA programmable charger.

and a second separate 6VDC battery to power the motors. Instead, our Rocket robot used the one set of four AA NiMH batteries – the batteries power the robot motors directly, while a step-up converter provides the 5VDC power needed for the Arduino Uno board. Everything runs happily and you only have the one set of batteries to charge. Step-up DC-DC converters sell on eBay from around $1.50.

BATTERY CAPACITIES

The next important factor is the battery capacity. The capacity generally tells you how long it'll last. However, the greater the current you draw from that battery, the more the capacity is degraded. For example, a 2,000mAh battery should last for 10 hours being discharged at the rate of 200mA, but up the rate to 1,000mA and the battery might last 1.5 hours.

DECENT BATTERY CHARGER

This is a little off the script, but it's just so important – if you're using rechargeable batteries, buy a decent programmable charger. I use two different models – an AccuPower IQ-328 (similar to the Lacrosse BC700 and Opus BT-C700) for quick charging and a PowerEx MH-C9000 for serious testing. The more recent AccuPower IQ-338/Opus BT-C3400 handle both NiMH and 18650 Li-ion cells in one, but the Nitecore NEW i2 (two-cell) or NEW i4 (four-cell) are also worth a look.

THINK BEFORE YOU DESIGN

Some will no doubt think power technology is as exciting as watching paint dry, but when you're making your own gadgets, you've got to think early on about how you'll power them. Ensuring you have an efficient, cost-effective power solution that delivers sufficient power will go a long way to making your project a success.

Machine Learning 101 — Part 2: Classification

It's one of the most popular forms of machine learning in use today. Darren Yates explains the basics of classification.

You're in charge of home loans at a major bank – how would you tell if a particular loan application could be a bad risk? You're a developer at a large software company – how would you detect if an email was spam or not? Or you're a researcher at a medical institute – how would you determine whether a patient is more or less likely to redevelop cancer? As varied as these situations are, they're all examples of the need to predict the category outcome or 'class' of an event or 'instance'. Financial planners are quick to say past performance is no indication of future investment returns, but a major focus of machine learning is prediction by learning the past. This month, we continue our series on Machine Learning looking at the learning technique called 'classification'.

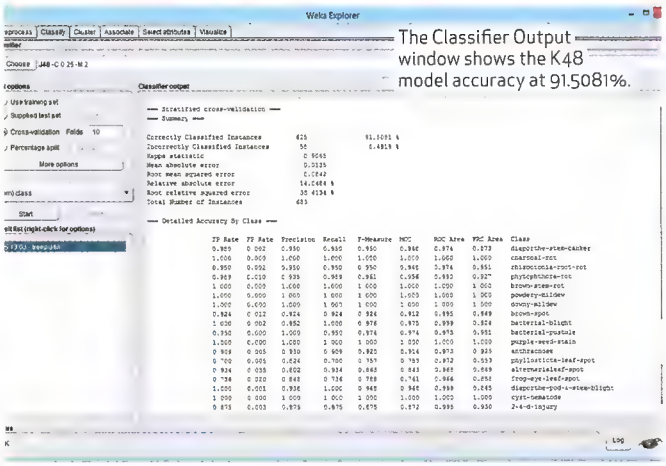
LEARNING THE PAST?

Whenever you learn something new, whether it's playing a sport, a musical instrument or board game, you're learning the rules of that activity, the actions that define how that activity works. But say you're watching a game of rugby league for the first time – could you learn how the game works just by observation? Actually, yes, you could.

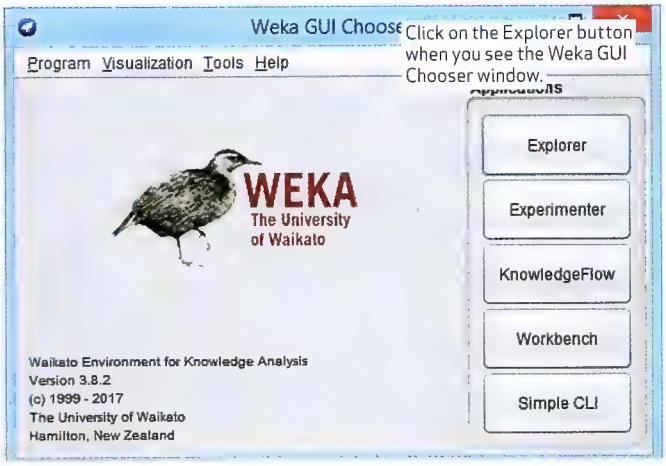
What makes learning possible in these situations is the rules governing them are generally constant and those rules exhibit themselves as 'patterns' of activity, so while you might not be an expert in rugby league, Monopoly or whatever, you can observe the patterns of activity. That's what machine learning in general does, the technique of 'classification' in particular – they learn patterns. Much of life revolves around patterns, though many are often hidden, which is why machine learning is being applied to everything from medical diagnosis to home loans, retail shopping to voice recognition. If a particular context or domain exhibits consistent patterns of activity, then machine learning can potentially learn those patterns.

However, when you learn from observation without knowing the rules, you need enough observations

Classification works on almost anything, including Soybean disease diagnosis.


Weka Explorer
Classifier output
Correctly Classified Instances 625 91.5081 %
Incorrectly Classified Instances 58 8.4919 %
Mean absolute error 0.0135
Root mean squared error 0.0842
Relative absolute error 14.4484 %
Root relative squared error 35.4134 %
Total Number of Instances 683

The Classifier Output window shows the K48 model accuracy at 91.5081%.



Click on the Explorer button when you see the Weka GUI Chooser window.

that cover every possibility to perfectly understand the game or context. For example, watch rugby league for one minute and you would learn that players on the same team pass the ball to each other. Imagine after that one minute, you're plucked out of the crowd and thrown into the game. You pass the ball forward to a team-mate standing closer to the opposition try line than you. All of a sudden, the referee blows his whistle and calls a 'forward pass'. Now unless you observed a forward pass ruling during that initial minute of learning, you wouldn't know the 'forward pass' rule. The same issue applies in machine learning – to learn an application's patterns perfectly, sufficient observations or 'instances' are required that cover all eventualities.

In practice, however, that rarely happens – the data available to you can often be incorrect in places or incomplete, insufficient, inconsistent or even irrelevant. While these issues can all have a negative impact on machine learning accuracy, there's a field of study called 'data preprocessing' that aims to minimise their effects.

Still further, you may be in a situation where no data exists and you're tasked with sourcing it. This is where the advice and experience of 'domain experts' can be invaluable, people who have expert-level experience in the area or 'domain' you're trying to learn or 'model'. They may not have all the answers (which may be why you're applying machine learning), but domain experts can help point you in the right direction and ensure you're gathering relevant data.

DATASETS

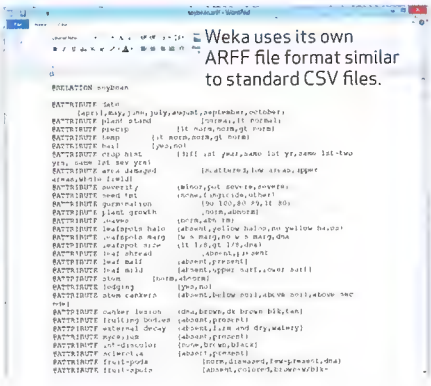
The way machine learning uses observations is through a set of training data or 'training dataset'. In many cases, this is just a spreadsheet of similar events – each row represents an individual event or 'instance' and the columns represent features or 'attributes' of those events. Each instance is a stand-alone entity in no particular order.

The classification task relies on the training dataset also having an attribute that represents the group or 'class' each instance belongs to. For example, for home loan determinations, the class value for an instance could be 'bad-risk' or 'good-risk'. If we're detecting spam emails, it could be 'spam' or 'not-spam'. If we're detecting hand-written characters, the class attribute values could be the character written, for example, one of the digits '0' to '9'.

Classification is an example of 'supervised' machine learning, because each instance in the training dataset has already been classified. What classification does is to learn the patterns that link each instance's attribute values to a particular class. In the example of spam detection, one attribute could be the number of continuous letters that were capitalised, another, the frequency of certain words as a proportional of all words appearing in the email. The class attribute will show whether each email instance in the dataset was classified as 'spam' or 'not-spam'.

Since every email is different, classification's role is to identify the underlying patterns that make one email spam and not another. Once we know those patterns, we can then use them to predict the spam status of new incoming email.

However, when it comes to more complex tasks, such as disease diagnosis, we may not know all the factors that affect the outcome. If we don't know all the important attributes, we can't know all the patterns and the ability to predict outcomes will be less than perfect. That's why care must go into sourcing good data – you won't always get perfect data, but generally the better your training dataset, the better your results.



Weka uses its own ARFF file format similar to standard CSV files.

EXAMPLE

Grab the Weka data-mining suite from the University of Waikato website (**tinyurl.com/ybmrzt2m**) if you haven't already and install it. If you don't have Java installed, download the 'weka-3-8-2-jre-x64.exe' version that includes it.

Launch Weka and when the Weka GUI Chooser window appears, click the Explorer button. With the 'preprocess' tab selected, press the Open File button and from your Weka installation folder, open the 'data' subfolder and the 'Soybean' dataset. This dataset was developed to learn the factors determining different types of diseases affecting soybean crops. Researchers aimed to create an 'expert system', a machine-learning system that, in this case, could diagnose crop disease like a human expert.

The Soybean dataset has 683 instances or events, each with 36 attributes describing factors of a disease event. Each instance includes a class attribute, whose values represent the type of disease noted for that instance. On Weka's Attributes panel, scroll down to attribute 36, 'class', click on it and you'll see its distribution on the lower-right panel. There are 19 different disease types noted in this dataset with four diseases prominently represented.

TWO STEPS

Classification is a two-step process –

first, you learn the patterns of the training dataset to create a set of rules or 'model' that summarise the patterns; and second, you test the model to see how accurately it can predict the class value of new but known instances.

The first step applies a classification algorithm to the dataset. An algorithm is just a computer program for achieving a certain task a particular way, a bit like a recipe. The algorithm learns the dataset patterns and creates a model that follows those patterns as accurately as possible. There are hundreds of classification algorithms, each using a different learning technique – they can involve a decision tree, Bayesian probability, or even a group of decision trees called a 'decision forest'. There are many more.

Whichever technique you use, the key to the learning process isn't necessarily to learn the dataset perfectly. Learning the dataset well only learns you the dataset, which might not represent the whole domain you're trying to learn. This can lead to 'overfitting', where the model learned is so specific to that dataset, it can't deal with new instances it hasn't seen before.

However, once you have a model, the second step is to test how accurate it is. This is the 'evaluation' step of getting the model to predict the class value of already-classified instances. To ensure you don't end up with an over-fitted model, there are a number of evaluation methods. One standard method is to split the original dataset into two subsets of instances, a 'training' subset and a 'test' subset. You run the classification algorithm over the training subset to first learn and build your model, then you test the model against the test subset with the class values removed to see how it performs. Since the model has not previously seen any of the instances in the test subset, this becomes a genuine test for the new model's ability to predict previously-unseen data.

However, by splitting the dataset in two, your model only learns the patterns of the training portion of the overall dataset, not the testing portion, potentially missing important information, which can be an issue, particularly with smaller datasets. One solution is a technique called 'cross-validation'. Here, the dataset is split into a number of equal-sized partitions, say ten. Nine of those ten are used as the training subset to learn the model, the tenth partition is used for testing. However, the process continues as a 'round robin' – in this case, it's run ten times, with each of the ten partitions taking turns to be the testing dataset. This way, the model now learns from every instance.

EXAMPLE

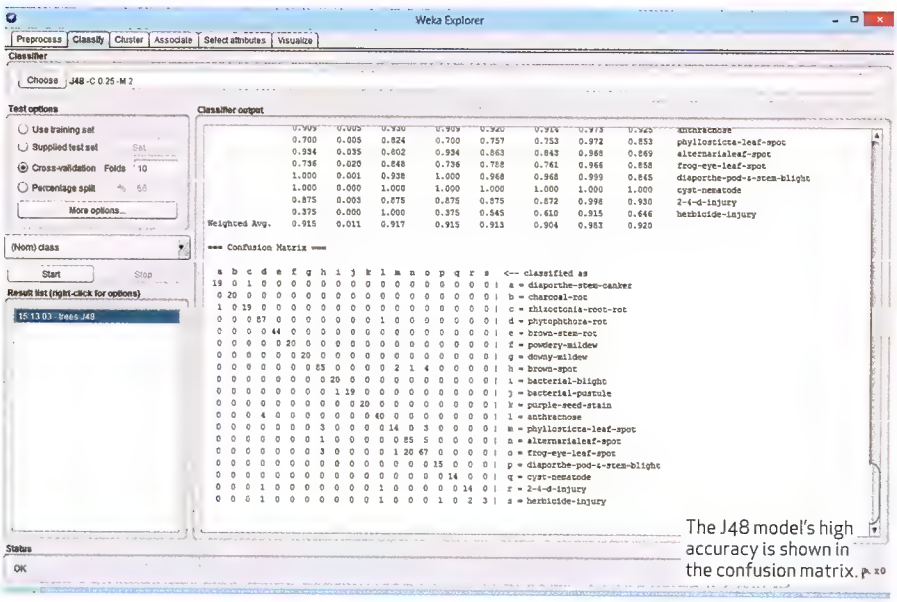
With the Soybean dataset preloaded into Weka, click on the Classify tab and under Classifier, click the Choose button. From the drop-down menu, select the Trees arrow and 'J48' from the sub-list. As we mentioned last month, J48 is Weka's implementation of the popular C4.5 decision tree algorithm. In the 'Test options' panel, you'll see various evaluation options, including 'use training set' and 'cross-validation'. Ensure the 'cross-validation' radio-button is selected and press the Start button.

CLASSIFICATION ACCURACY

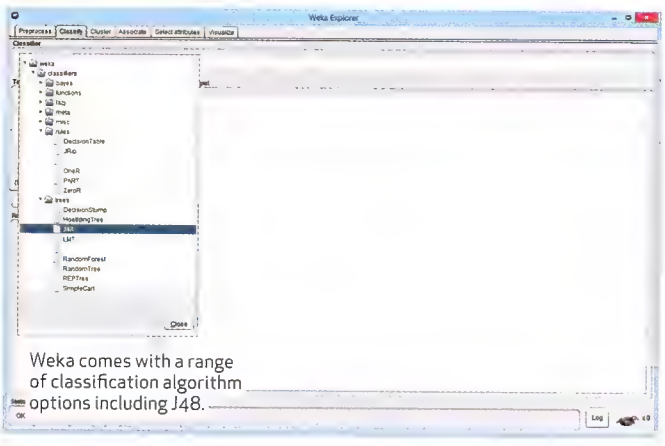
How do you evaluate classification model accuracy? You run a number of instances, each with a known class value, through the model, but with the class values removed, so that the model has to figure out what each class value is. You then compare the predicted class value for each instance against its original class value. Next, you add up the number of instances the model correctly predicts the class value for and divide it by the total number of instances tested, multiply by 100 and get a percentage. If, for example, a model correctly classifies 184 test instances out of 200, it's 92% accurate.

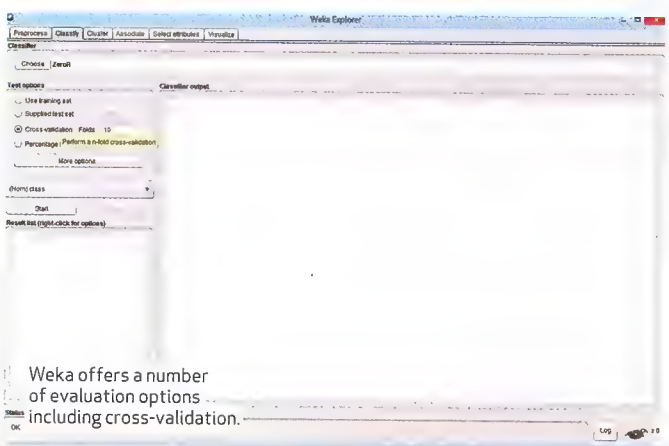
EXAMPLE

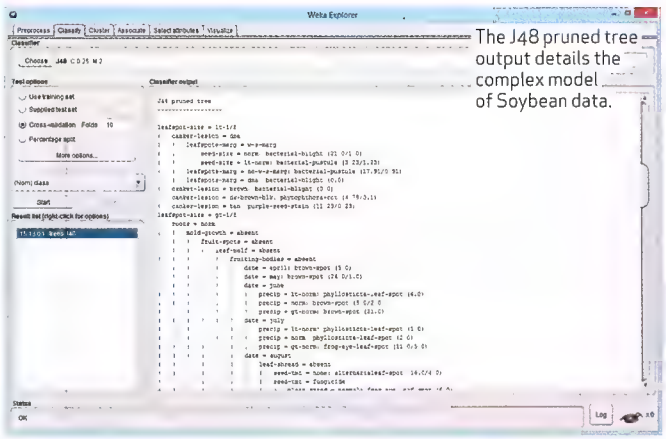
Scroll through the Classifier Output panel until you get to 'J48 pruned tree'. The ASCII art you see below is the tree model the J48 algorithm has built after pouring over all 683 instances and their 36 attributes. Below the tree art, you'll see the 'Number of Leaves' is 61 and the 'Size of the tree' is 93. Each line of the ASCII tree here represents one of the 93 tree entities – of those,



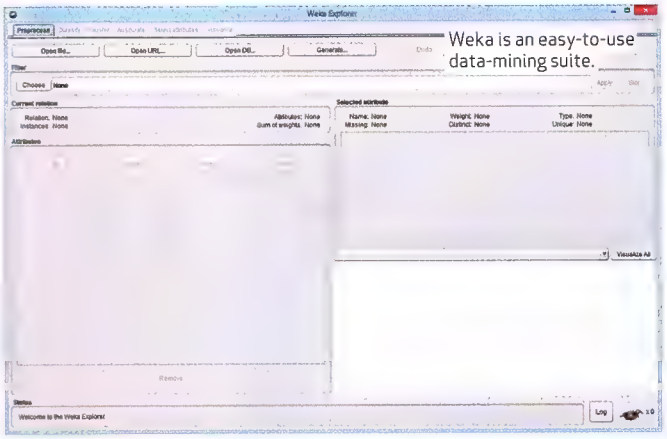
The J48 model's high accuracy is shown in the confusion matrix.


Weka comes with a range of classification algorithm options including J48.


Weka offers a number of evaluation options including cross-validation.



The J48 pruned tree output details the complex model of Soybean data.



Weka is an easy-to-use data-mining suite.

61 are 'leaves', the predicted class value options based on the possible branch outcomes. We'll go into more detail on decision trees another time.

At this point, scroll down until you get to 'Stratified cross-validation' and you'll see the 'correctly classified instances' number 625 out of 683 instances or 91.5081%.

CONFUSION MATRIX

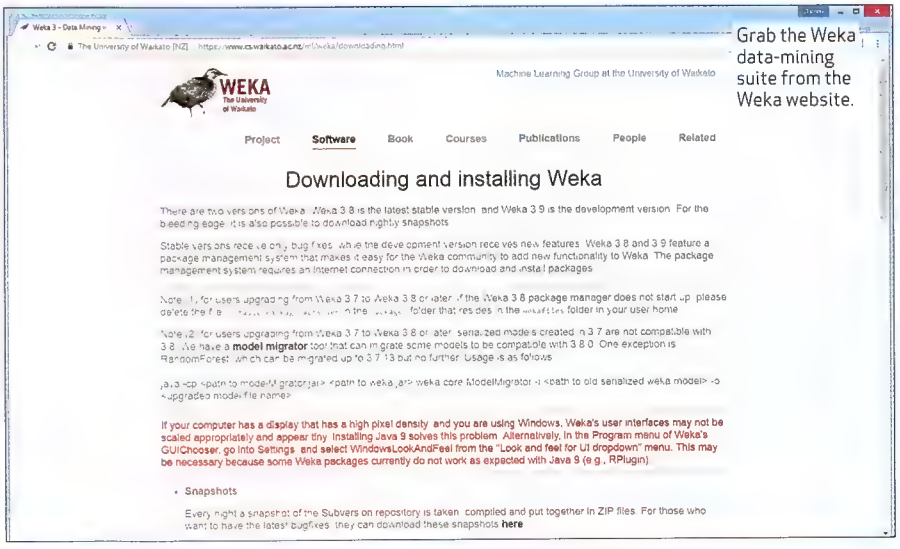
We talked about this briefly last time, but scroll to the bottom of the Classifier Output panel and you'll see a matrix of numbers called the 'Confusion Matrix'. While the accuracy percentage gives you a one-dimensional overview of how well the model can predict the class value of dataset instances, the confusion matrix gives you a more exact picture by class value. It shows the original instance class values (in rows) against the class values predicted for each instance (in columns). For example, if you look at the bottom row, 's=herbicide-injury', the numbers in this row are the number of instances originally classified as 'herbicide injury'. Add up the numbers in the row and you get eight (3+2+1+1+1). The '3' in the 's' column means the model correctly predicted only three of those eight instances as 'herbicide injury'. It incorrectly predicts two as '2-4-d-injury', one as 'diaporthe-pod-and-stem-light' and so on. However, go to row 'e' and all 44 instances originally classed as 'brown stem rot' are correctly predicted as 'brown stem rot', so from this, we know this model is much better at predicting 'brown stem rot' than 'herbicide injury'.

EXERCISE

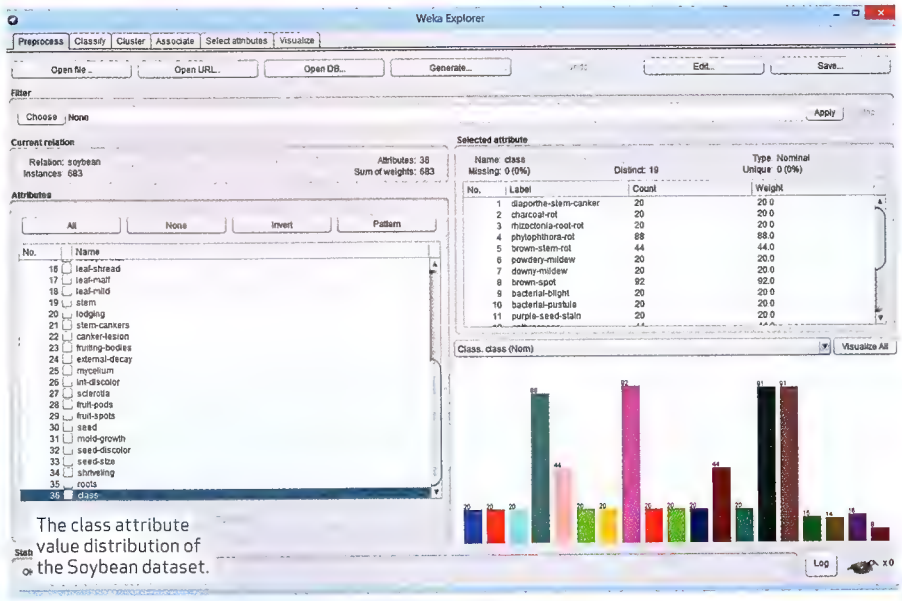
Try running other classification algorithms using this dataset. What accuracy do you get with RandomForest? How does it compare with J48 or REPTree? What do the confusion matrices of other models tell you?

GOOD DATA THE KEY

Classification algorithms like C4.5 and RandomForest are extremely powerful learning tools, but they all depend on good data to obtain maximum accuracy. In the real world, datasets have missing values, even wrong values that can impede any classification algorithm. Ultimately, the perfect algorithm doesn't exist yet, which is why there's a continuous stream of new algorithms being developed. Still, the fact that classification not only can provide insight into hidden patterns within data, but also predict the class of new unseen instances is what makes it so valuable in the world of machine learning. ■



Grab the Weka data-mining suite from the Weka website.



The class attribute value distribution of the Soybean dataset.

downtime

» CARMEL SEALEY LEVELS UP AND HEADS ONLINE TO FIND OUT THE LATEST IN GAMING NEWS

PUBG creators suing Epic Games over 'copycat' Fortnite

SIMILARITIES ABOUND.

PUBG Corp has filed a lawsuit against Epic Games for copyright violation. *Fortnight*'s free-to-play battle royale mode was released in September 2017, and *PUBG*'s publisher Bluehole was quick to weigh in on the similarities between the two titles. However, while Bluehole made note that it was not the battle royale mode itself that concerned the company, it did say that it was worried "that *Fortnight* may be replicating the experience for which *PUBG* is known" and emphasised that this was a problem due to Epic Games being the company responsible for the engine that *PUBG* paid to use.

Fortnite finally coming to Android

SO BEGINS THE NEXT BIGGEST MOBILE GAMING CRAZE.

This title has become something of a phenomenon in the gaming community. Originally launching on consoles back in 2017, its arrival on iOS was eagerly welcomed and has netted Epic Games some serious dollars in microtransactions alone. And it seems as though Android users won't have long to wait, with the company announcing it will be launching "this summer" (our winter), although a precise date is as yet unknown.

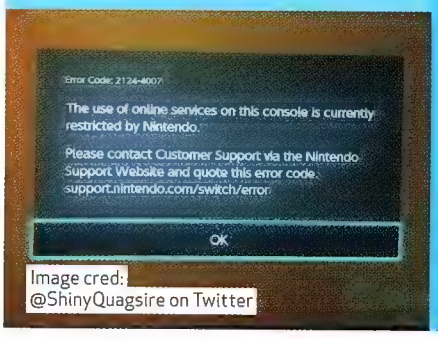

Error Code: 2124-4007
The use of online services on this console is currently restricted by Nintendo.
Please contact Customer Support via the Nintendo Support Website and quote this error code.
support.nintendo.com/switch/error
OK

Image cred: @ShinyQuagsire on Twitter

Steam cracks down on games with sexual content, then changes its mind

Japanese developers targeted in series of measures aimed at censoring underage nudity.

In mid May this year, three developers claimed to have received emails from Valve, asking that they censor their games due to a violation of Steam's guidelines on pornographic content, or face having them removed from the Steam platform. All of the games in question (namely, *Mutiny!!*, *HuniePop* and *Tropical Liquor*), while varying in genre, all share the same anime-style visuals, feature overtly sexual themes, nudity and suspiciously young-looking teenage girls. Naturally, fans of the games were dismayed and angered at this news, with some claiming that it has racist undertones, as all the developers were Japanese.

Valve has since informed the developers in question that they could disregard the strongly-worded emails about their games' impending removal from Steam. However, far from being let off the hook, Valve has added that these titles' offending content would be re-evaluated, insinuating that they could still be pulled from the platform.

Unpatchable exploit makes Nintendo Switch homebrew possible

BUT THERE'S A CATCH...

Soon after its March launch in 2017, a GPU exploit was revealed in the Nintendo Switch, one which could be used to run unofficial software, such as pirated games and homebrew ROMs. This led to heightened interest from the hacking community, resulting in the discovery of a new 'unpatchable' exploit to be taken advantage of by pirates. Nintendo isn't about to take this attack on its walled garden lying down, however. The Japanese company has begun banning hacked consoles from its online services, sending error notifications when users attempt to log in and pointing them to customer support. While banned consoles can still receive and download software updates, they will be restricted to playing offline, with access to the eShop blocked.

According to Switch user Shiny Quagsire on twitter, however (see left), the ban also extends to the account of the blocked Switch, meaning those with multiple Switches would find all devices banned, not just the hacked one.

Steam game-streaming iOS app rejected by Apple

Android version still available for PC gaming on mobile or tablet.

In a rather unexpected announcement, Valve has reported that Apple has rejected – after first approving – the Steam Link app for iOS. The app would have made it possible for iPhone, iPad and Apple TV owners to stream their Steam library games to those Apple devices, a service "similar to numerous remote desktop applications already available on the App Store". However, according to a Valve press release, "Apple revoked its approval citing business conflicts with app guidelines that had allegedly not been realized by the original review team".

Despite the fact that Valve's Android Steam Link app is available (and free) to download from the Google Play store, Apple is, for now, digging in its heels. Valve hopes that Apple will reconsider its judgement, but in the meantime, it looks as though iOS and tvOS users are out of luck on the Steam Link streaming front.

PlayStation 4 is 'end of life' according to Sony

The PlayStation 4 launched to great fanfare back in November 2013 and has gone on to sell 79 million units. While the company has since released two variants of its successful gaming console — namely, the PlayStation 4 Slim and the Pro, both released in 2016 — CEO John Kodera has hinted in a corporate strategy meeting that the PS4 could be nearing the end of its life. This could be partly due to the slowdown in yearly sales, which is expected to fall to *just* 16 million this year compared to the 19 million of 2017, but also due to the fact that the number of potential customers are simply running out. Sony is still very supportive of the console, however, as its active PSN user count is a healthy 80 million per month.

According to reports from the investors' strategy meeting, Kodera suggested that the console would be phased out over the next few years, hinting at the fact that 2020 could herald the arrival of something new — potentially the launch of a PlayStation 5 console. We eagerly await further news on this front.

School-shooting-themed game briefly released, then banned from Steam

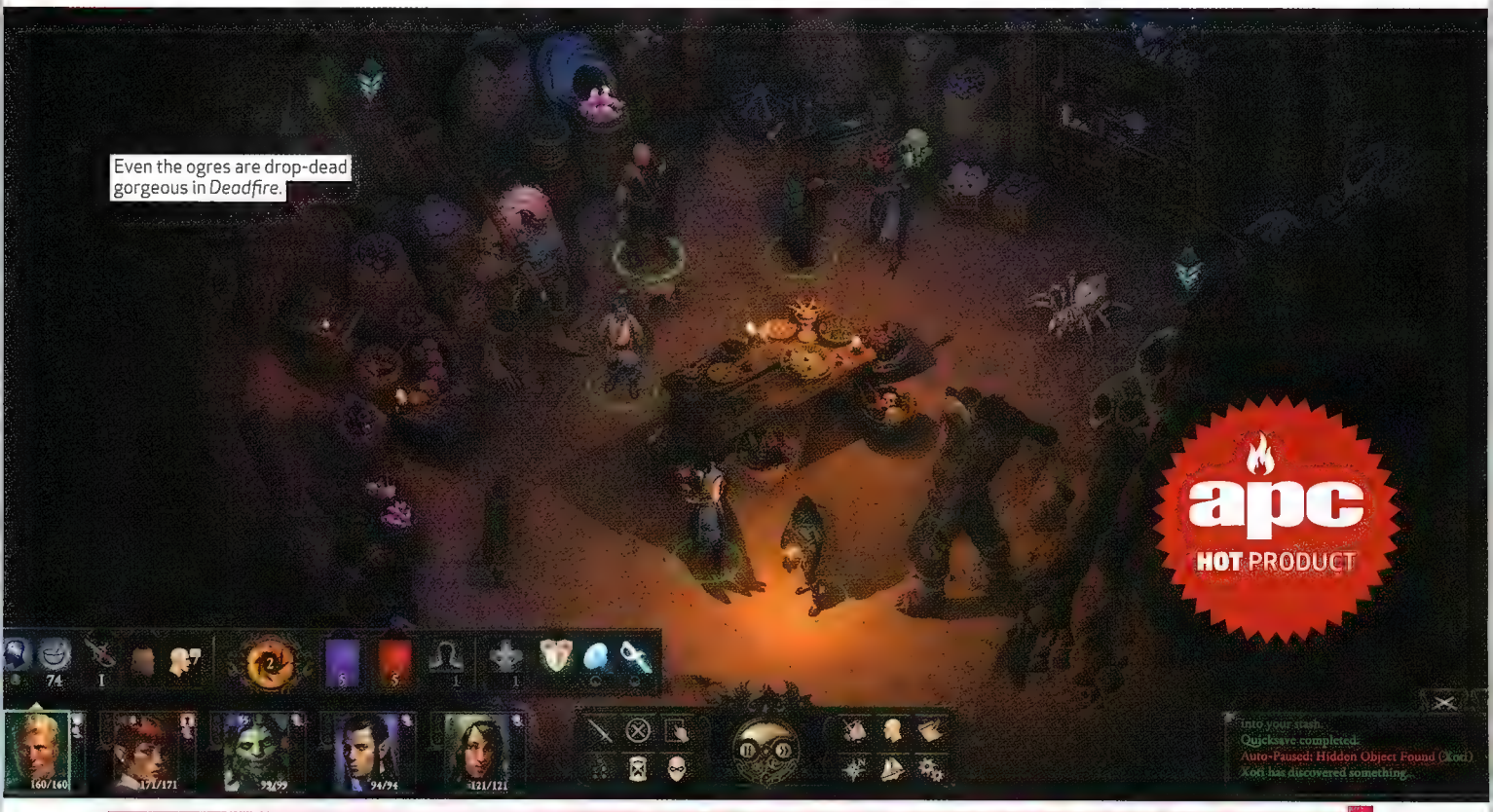
THREE GUESSES WHY...

The FPS titled *Active Shooter*, which released on the Steam platform towards the end of May, has been removed, and its developer Revived Games and publisher Acid have been banned. According to Valve, the man behind the game "who had previous been removed" under another name "is a troll, with a history of customer abuse, publishing copyrighted material, and user review manipulation". Despite the fact that this was the cited reason for the ban, we wonder whether it would've lasted very long anyway, as the game purportedly offered gamers the opportunity of being the titular school shooter, and petitions had been circulating online for its removal.

Nintendo patent stirs rumours of new console

COULD THIS BE THE N64 MINI?

Nostalgia is a powerful tool, and the highly successful launches of both the SNES Classic Mini and the Nintendo Classic Mini: SNES are pretty much a case in point. And it seems as though Nintendo knows it, having recently applied for a trademark in Japan for "N64". Sure, this isn't cold, hard proof that the N64 Mini could be just around the corner but it's another clue, adding to the patent Nintendo filed with the EU Intellectual Property Office last year for its controller design...!



Even the ogres are drop-dead gorgeous in *Deadfire*.

PC | FROM US$59.95 | ETERNITY.OBSIDIAN.NET

Pillars of Eternity II: Deadfire

The classic isometric RPG finally gets the spit-shine it deserves.

Nostalgia is a powerful force in the entertainment landscape, but even given the sheer abundance of throwback media products on offer, it's rare to see a revival that can truely match the source material.

Pillars of Eternity II is, to its enormous credit, one of those "exceptions that make the rule". A follow-up to the eponymous 2015 original, it's again a game built largely in homage to *Baldur's Gate* and the isometric PC RPGs that were popular throughout the 1990s. *Pillars II*, however, outdoes its predecessor in several key areas – and as a result, it feels like a true (and modern) heir to the throne.

It gets the basics right. This is a game that's as much about negotiating your way through conversational conflicts with myriad multi-cultural fantasy denizens as it is about killing monsters in goregeously illustrated dungeons. Critically, though, *Pillars II* polishes up and rethinks the original's shortcomings – most critically, all in-game dialogue is now fully voice acted, meaning players no longer have to commit to reading reams of speech-rendered-as-text and often feeling like they're playing an interactive novel. It's hard to overstate how much of a difference this seemingly small change makes to the experience as a whole – it dials up the immersion and engagement, and really makes the world come alive. In short, it makes the game feel, well, more like a game.

Developer Obsidian has also made some smart snips, like limiting your party to a slightly more manageable five characters, rather than six, and they've combined that with a customisable and reasonably flexible party AI system that means less stopping and starting (and micromanagement) while in combat... although, critically, not so much that you can just pop off for a cup of tea while battles sort themselves out.

The world map has also been overhauled to give players much more freedom – with the setting having moved to the Deadfire Isles (which resembles a sort of colonial-era Caribbean), your home base is now a ship, which you can freely use to sail and explore wherever you like... although there's no guarantee you'll be able to handle what you'll find.

All those new ingredients add up to a reformulated recipe that, while keeping the core flavours largely unchanged, makes *Pillars II* friendlier, more consistently pacy and – for those who like this kind of isometric-RPG dish – an absolutely scrumptious affair. This is a delicious masterwork that equals the best the genre has to offer.

■ Dan Gardiner

Sorry, I must have taken a wrong turn... we were just looking for the bathroom.

Verdict

***Baldur's Gate* fans, your ship has docked: Obsidian has delivered an isometric RPG worth of the classics.**

★★★★★

apc HOT PRODUCT

PC, PS4, XO | FROM $9.55 | TELLTALE.COM

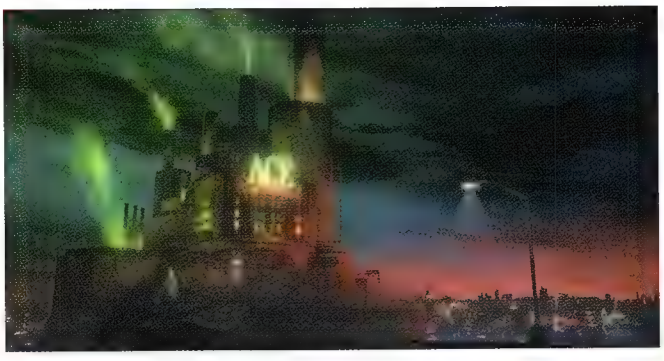
Batman: The Enemy Within — The Telltale Series

Making a monster.

The idea that Batman and The Joker are more alike than the former will admit – "two threads in the same stitch", as this game puts it – isn't new, but it's never been explored quite like this. The first season of Telltale's take on *Batman* was hit and miss for us, but it laid solid foundations with its startlingly original take on the caped crusader and his enemies. This second go has built on them admirably, crafting a far more consistent and compelling story.

The setup sees Batman facing off against super-villain group The Pact, with each member a fresh take on a classic villain – from Bane to Riddler to Mr Freeze. Particularly enthralling is Telltale's Harley Quinn, here a charismatic yet brutal leader invested with genuine agency of her own, rather than a sidekick or victim.

There's action and mystery aplenty across the five episodes, but the real core of the story is the relationship between Bruce Wayne and 'John Doe'. John is a sort of



Joker-in-the-making, deeply troubled and in the sway of criminals, but not yet the murderous agent of chaos he might become. Crucially, thanks to the events of his introduction in the first season, he sees Bruce as his closest friend and role model and how you navigate that relationship shapes his personality for both better and worse. It's a fascinating twist on the classic pairing – in every warm moment or sudden spat, our memories of the hundreds of Batman-Joker stories that have come before add brilliant tension.

And, ultimately, the player is given a remarkable amount of freedom in how things end up. As with all Telltale games, many events are set in stone, but there's more genuine divergence possible here than we've seen in its past titles. The last episode, particularly, changes hugely based on your choices.

After a rocky few years, this is Telltale back on top form, with one of our new favourite *Batman* stories in any medium.

■ Robin Valentine

Verdict

The game plays with, and frequently subverts, your expectations of a Batman story. It's brilliant.

★★★★½

Conan Exiles

A survival game that sheds some of the genre's annoyances.

PC, PS4, XO | $79.95
WWW.CONANEXILES.COM

The survival genre is a tough one, both for developers and players. The likes of *DayZ*, *Rust*, *The Forest* and until recently *Ark: Survival Evolved* seem stuck permanently in Early Access. For players, this means coming to grips with any given game's quirks and bugs. *Exiles* is a bit of an anomaly: it stayed in Early Access for a single year (*DayZ* is approaching its fifth!), and now that it's launched into version 1.0 across all platforms, it plays pretty seamlessly. You'll start *Conan Exiles* as either a scantily clad man or woman with nothing, as is customary. You'll need to gather resources like plants, branches and stones in order to build tools in order to harvest better goods, which will let you build bigger stuff, which will lead to even more resource-demanding goods. It allows you to play offline, meaning other players can be avoided. It's actually a great way to play, as interactions with real players in games like these hardly contribute to their sense of realism. The combat system here is much more fleshed out than the competition, with the ability to dodge and hold up a shield. If you're curious about survival games, it's much easier to recommend *Conan Exiles* than *Ark: Survival Evolved*. At times, it feels more like an action RPG, and that alone should hook you.

■ Shaun Prescott

★★★

Weapons are easy to come across but think before you shoot: noise will attract the hordes.

PC, XO | $49.95 | WWW.STATEOFDECAY.COM

apc HOT PRODUCT

State of Decay 2

A complex and unique survival sim with a hard edge.

With news of the arrival of yet another zombie game, you'd be forgiven for immediately turning away. But wait: *State of Decay 2* is probably the best zombie game of this generation (and in my opinion, of all time).

Few major console titles dare ask as much from the player than this sequel, both on an emotional and cerebral level, and what results is a survival simulation that feels less like a grindhouse retread and more like a meditative, tense, existential journey.

The format is barely changed from the first *State of Decay*: choosing from a few survivor archetypes, you're set loose in a collapsed society, where you're forced to gather resources and build a pathetic semblance of normality amid the ruins.

Early in the game, you'll have a small handful of survivors you can take control of in order to bolster your settlement (via some light, but surprisingly detailed, management elements), clear out zombie hordes and make contact with other survivor communities.

Survival is key here: each of your characters can die, and permanently. Within the first four days of my first playthrough, the two chief characters in my settlement had been brutally murdered by an aggressive survivor community, leaving just three remaining (miserably).

While the writing in *State of Decay 2* is hardly worth writing home about, to put it kindly, it's the emergent elements that matter, and this is a game where each player will inevitably have their own stories to tell. Should you choose to focus your settlement on weapon development rather than, say, health is a decision that might not seem dramatic at first, but can have significant repercussions as a playthrough proceeds.

It's a survival game in the purest sense: you won't be punching trees, you won't be grinding resources to build an axe: you're keeping people alive in a harsh, aggressive world. Each time you take a character from the settlement into the wastes, there's a strong sense that anything can happen. But it's not because the game will kill you at random: rather careful play, careful consideration and careful planning will hold you in good stead.

You can have real-life friends come along for the ride via online cooperative play, too, though the functionality is limited and you unfortunately can't team up for settlement building.

Meanwhile, the graphics are improved over its predecessor but *State of Decay 2* is by no means a pretty game. But what it lacks in triple-A presentation, it more than makes up for in depth. This is a sandbox in the purest sense. Player agency is the priority, and across three massive maps and a large cast of avatars, there's a startling abundance of stories and experiences to be had in *State of Decay 2*. Turn away from this at your peril.

■ Shaun Prescott

Verdict

A deep and engaging survival game with not a punched tree in sight.

★★★★★

PC | $50 | WWW.TOTALWAR.COM

Total War Saga: Thrones of Britannia

An old series gets Offa on the right foot.

Being a king is simple, right? Wrong. Nobody ever mentions the betrayal, the demands or the crushing and constant requests for equitable wealth distribution.

Thrones Of Britannia does something no *Total War* has done before – make you feel like an actual king. Instead of being an unquestionable, omnipotent monarch, you muddle through a febrile peace in one the most tumultuous periods in British history – 878 AD. The Vikings have been stopped but not defeated; Britain is still occupied; and various hungry powers tear at the flesh of a kingdom too small to share. And as the leader of one of the game's 10 playable factions, it's your job to carve yourself a healthy slice. Every success is shared. Every failure is your fault.

That all sounds very *Total War* and it looks familiar, too. At first glance, nothing much seems to have changed. We're back in the British Isles, where we've been in so many previous games in the series, but it only takes five minutes with the new campaign map to appreciate the differences. This is the richest *Total War* map to date, densely packed with walled cities and satellite villages, featuring focused, engaging points of conflict.

Whereas your main cities are garrisoned and can repel an invading army, the smaller settlements are completely helpless. Unless your army is nearby, they can be sacked or occupied without a fight. But this is one of the game's many clever tweaks, and it forces you to play differently. Instead of a network of neatly defended towns, you're encouraged to range across your borders with an agile, reactive force. Fight on too many fronts and it's impossible to defend your lands. This forces you to consider every conflict, expand carefully and be constantly wary of your neighbours.

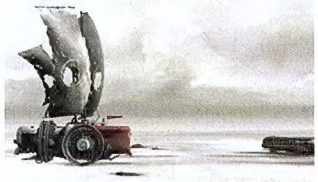
It also leads to another first: being locked in constant conflict is a terrible idea. There's a war fervour meter, which will decrease as you spend time locked in fruitless campaigns. Your subjects will start to crave peace, and become dissatisfied. These thoughtful, almost punitive touches force you to consider everything before committing to a campaign.

Another layer of realism comes from the way units are recruited and upgraded. Military buildings are gone, instead, you upgrade your troops via tech trees. Recruited units start in a depleted state and gradually grow to full strength. Battles still feel very similar, though, so if you didn't love the combat in previous games, this won't convert you. But this is a welcome new direction for the series. ■ **Matt Elliott**

Verdict

***Occasional War Saga* might have been a more accurate name for this exhilarating departure from the norm.**

★★★★½



Far: Lone Sails

Never truly alone.

PC | US$15
WWW.FAR-GAME.COM

About an hour into *Far: Lone Sails*, we're starting to understand how Tom Hanks ended up so attached to that volleyball. When you're faced with a whole lot of nothing, you begin to build odd little relationships with lifeless things. And what a nothingness this post-apocalyptic adventure boasts — a desolate, dried-up seabed. Your partner throughout the journey is a land yacht, your primary means of transportation, and the bulk of your time is spent caring for it. The cramped interior means we sometimes accidentally hit the wrong switches, but rushing about the contraption to keep its various sections in order is generally a kinaesthetic joy, while the machine's cheerful puffs of steam and good-natured groans begin to convince you it's anything but inanimate. The occasional puzzle will reward you by fastening new parts to your craft. None of the conundrums are particularly taxing, though, and are outshone by lightning, tornadoes, volcanoes and hail. It's disappointing that these are the only instances in which looking after your giant metal friend feels like a challenge. Our bond might have been even stronger when faced with a bit more hardship. Nevertheless, *Lone Sails*' strangely tranquil post-apocalypse is beautifully atmospheric, with a touching message. ■

★★★½

Violent video games ruled not fit for Olympics

But other, less-violent games could be in...

Late last year, the International Olympic Committee announced that "competitive 'esports' could be considered as a sporting activity", exciting some and confusing others. In the months since then, many have speculated as to which games would qualify, but the IOC has apparently made it quite clear (through correspondence with certain interested parties, including AliSports – a division of AliBaba) that the games under consideration would be non-violent in nature and involve sports somehow. While this is bad news for *Overwatch*, *PUBG*, *COD* and *Counter-Strike* fans, it might give other games their moments to shine on the international sporting stage, such as *Rocket League*, *FIFA* and *NBA*, or even *Mario Kart* and *Rayman Legends*' Kung Foot mini-game. If *FIFA* and *PES* are allowed, however, there would be an interesting debate surrounding the legalities of using professional personas within the teams vs the amateur rule for the real game in its Olympic form. Hmm...

PUBG ransomware discovered

PLAY THE GAME TO DECRYPT YOUR FILES.

Ransomware is a form of malicious software designed to encrypt your documents and hold them to ransom. In most cases, the creator of the malware will want money in the form of a cryptocurrency as payment before releasing the files back to you (if you're lucky). However, a new ransomware has been detected by the folks over at MalwareHunterTeam (**twitter.com/malwrhunterteam**) called PUBG Ransomware that demands a much less malicious method of payment: namely, play *PlayerUnknown's Battlegrounds* and your files will be safely decrypted. According to the ransom notice, the victim of the attack is asked to play for a full hour, but after some investigating, you only actually have to play the game for three seconds, making this particular virus a relatively painless one to experience. Evidently the creator thought he was being funny.

The Virtual Currency Girls

CRYPTOCURRENCY EDUCATION IN SINGING, SHORT-SKIRT FORMAT.

Songs can be written about many things: relationships, social issues, war, history, drugs, foxes and much more. So it stands to reason that, in this day and age, someone would sing about cryptocurrencies. The Japanese band The Virtual Currency Girls, or Kasotsuka Shojo, apparently want to "promote the idea through entertainment that virtual currencies are not just a tool for speculation but are a wonderful technology that will shape the future". Each of the eight members wears a different lucha libra-style mask (that represents a different cryptocurrency), fluffy white bear ears and short frilly waitress-style dress. While we're not brave enough to comment on what their outfits might symbolise, we can happily say that their songs are very poppy and catchy, with lyrical gems such as "Beware your password, don't use the same one", "The price might crash soon" and "Never forget to set up two-factor authorisation". (If that translation is to be trusted, that is...)

Apple HomePod version of Siri caught swearing

MIND YOUR LANGUAGE, YOUNG LADY!

Ask Siri to define a word for you and she will dutifully pull down a definition from the Oxford Dictionary. If the word you've asked for has multiple definitions, she may ask you whether you'd like to hear another. Ask your lady-in-a-tube to define the word "mother", and you will be informed firstly of the usual definition of the nurturing kind. Accept Siri's offer of an alternative definition, however, and you will most likely get an amusing shock when she tries to pronounce the word 'motherf**ker'. This isn't entirely her fault, however, since she is only quoting from her dictionary, but we're surprised Apple didn't put some sort of filter on it, nevertheless. We won't bother to tell you not to try this at home... We did — in the name of reporting, of course. She hasn't quite got the annunciation right, though, making the slip-up giggle-worthy. ■

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YOUR HANDS
WITHOUT
GOING
BLIND

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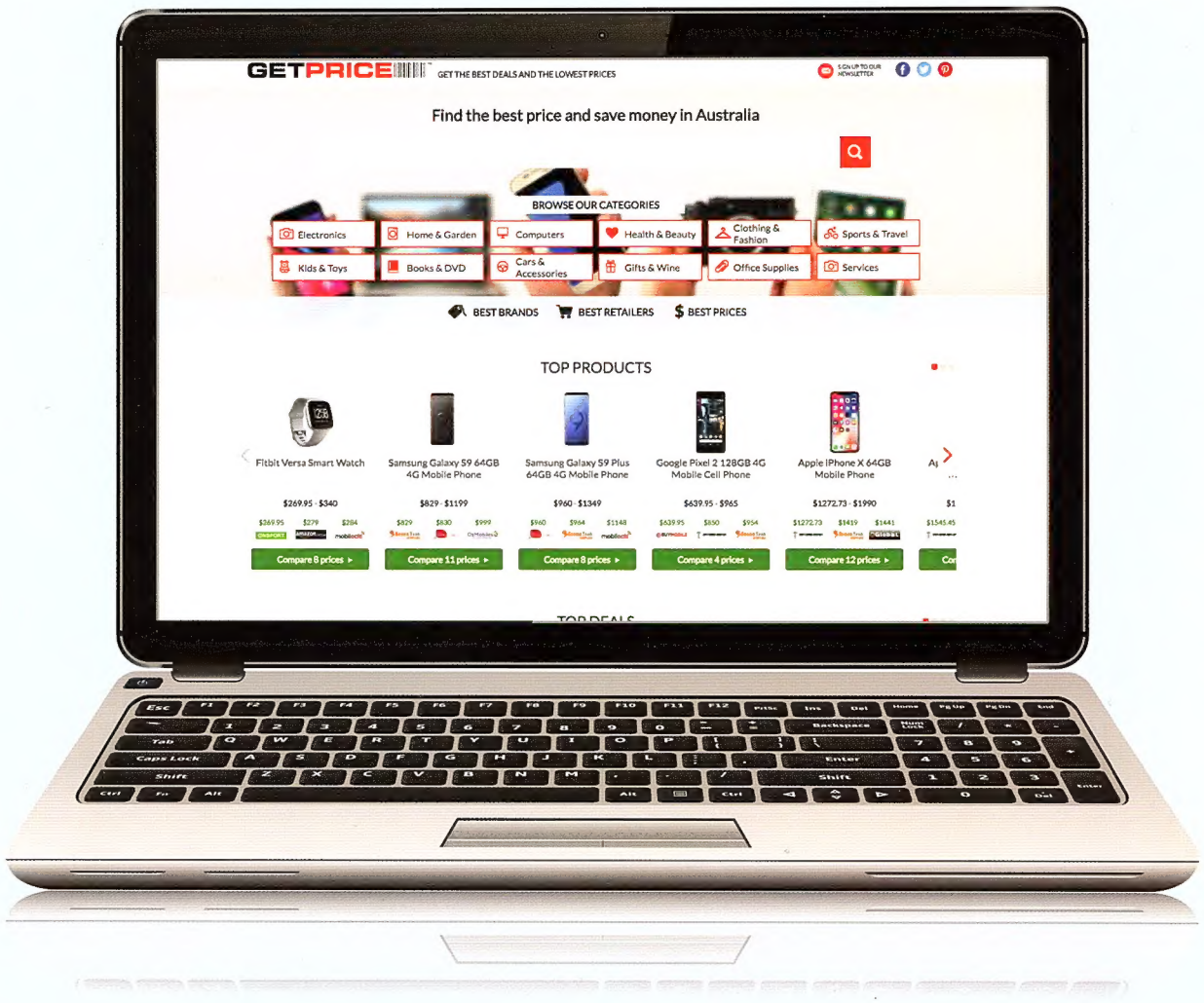

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